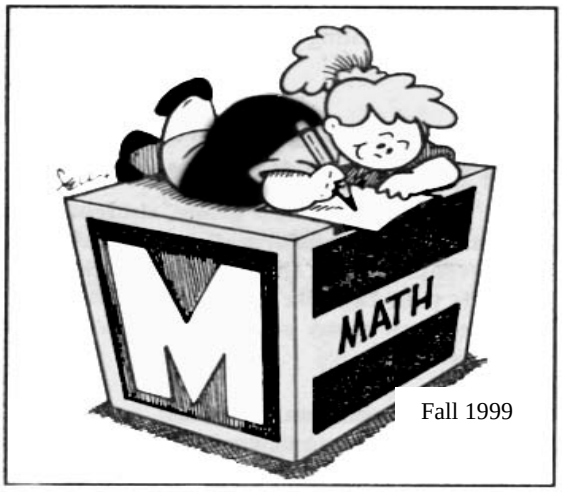
Multiple Classroom Assessments for Nebraska Mathematics Standards



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Multiple Classroom Assessments for Nebraska Mathematics Standards

Multiple Classroom Assessments for the Nebraska Mathematics and Reading/Writing Standards

Introduction

The purpose of this section of the STARS Toolkit is to provide guidance to Nebraska teachers as they assess student achievement related to the Nebraska mathematics and reading/writing standards presented in Nebraska L.E.A.R.N.S.

The STARS Toolkit focuses on classroom assessment. Students need frequent feedback about their academic progress. Teachers need feedback about whether students are learning information that is being taught. Good teaching and ongoing assessment are strongly linked to student success. In fact, the main purpose of assessment is to help students learn.

Again, the focus in this document is on classroom assessment for reading/writing and mathematics There are some examples in the following sections that could possibly be developed further and become part of a district's criterion-referenced assessment. However, this document was **NOT** created to be the district's criterion-referenced assessment. Issues of reliability, validity, and security would need to be considered.

The mathematics and reading/writing assessment samples in the toolkit were created by 40 Nebraska teachers during a week-long workshop in July 1999. Teachers who worked on this project represent districts across the state, work in grade levels ranging from kindergarten through grade 12, and have expertise in one or more of the following areas: mathematics, English language arts, library/media, Title I and special education. The July workshop focused on the following four goals.

GOAL I. **Develop a deeper understanding of the Nebraska mathematics and reading/writing standards.**
Teachers were asked to work in small groups within one content area (reading/writing or mathematics) and one grade span (2-4, 5-8, 9-12). Each group focused on one content standard at a time. The groups were asked to determine what students need to know (content) and what students should be able to do (processes) to meet a specific standard. Through this discussion, teachers outlined the content and processes that should be used to guide assessments. Administrators are encouraged to provide opportunities for similar discussions at the district or school level.

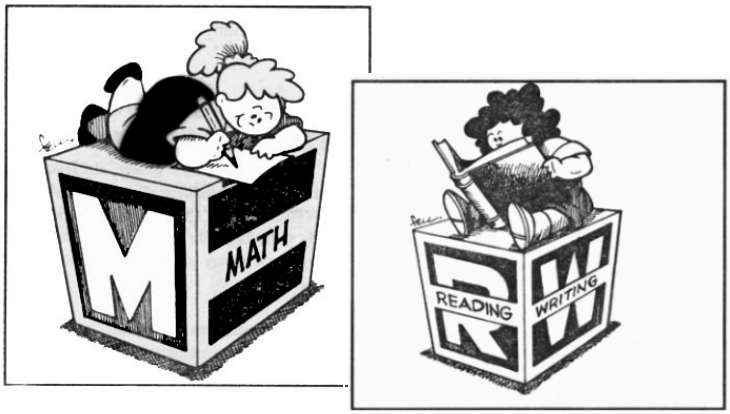
GOAL II. **Identify or create sample multiple assessments for each standard.**
This goal was achieved in two parts. First, mixed teams of mathematics and reading/writing teachers focused on one of six different types of assessment (selected response, constructed response, performances, products, observation, personal communication). Each team reviewed and discussed materials related to

the specific assessment type they had been asked to research. Each team provided a summary of their work. Summaries of six assessment types are presented in both narrative and table form on the following pages.

Second, the content area groups (described in Goal I above) used these summaries as a reference as they identified or created appropriate assessments for each standard. Since no single method of assessment can provide the full range of information about student achievement, content area groups were encouraged to identify more than one way to assess student performance on a standard.

GOAL III. Identify additional resources for assessing standards in the classroom.
Teachers brought resources from their own classrooms and districts, as well as resources developed by professional organizations and commercial publishers. This provided a wealth of information to share among colleagues. Assessment resources are an essential component that can provide high quality models and guidelines for teachers as they develop quality assessments for their own classrooms and districts. Educators are encouraged to share their assessment resources and explore other resources available in this toolkit. The Nebraska Department of Education, Nebraska's educational service units, teacher training institutions, and professional organizations also serve as resources for additional assessment information, providing individual district consultation and sponsoring workshops and conferences.

GOAL IV. Collect and analysis student exemplars over time.
As teachers use the assessments and collect samples of student work, we plan to gather these samples over the next year, reconvene the teacher group, and identify student exemplars for the four performance levels outlined in the STARS document and the STARS assessment toolkit. ESUs or local districts could follow a similar process.



Beliefs about Classroom Assessment

- **We believe that classroom assessment for all students should be:**
  - aligned to instructional goals,
  - an integral, enriching part of learning and instruction,
  - student-centered,
  - reflective of individual needs and cultural influences,
  - non-threatening and motivating,
  - on-going to provide ample opportunities for success,
  - aimed at development of self-assessment skills, and
  - communicated to a variety of audiences.

What does a "Good" Classroom Assessment look like?

- **Tests appropriate grade level and achievement of standards**
  Curriculum, instruction, and assessment are not separate. Assessment needs to be aligned with learning and teaching. Design/selection of assessment tasks requires clear knowledge of the curriculum objectives. Students should only be assessed on knowledge and skills their teachers have given them opportunities to learn and each task should be well within the capabilities of most students. Students must be given the opportunity to learn the content of the assessment prior to being evaluated.

- **Written at appropriate levels of difficulty and readability**
  The language of assessment must match the language of instruction and the students' level of learning. If not, then assessment produces undue language biases and invalid results. Students must be fluent in the language in which they are to be assessed and the level of language used in the assessment must match their stage of language development.

- **Contains clear, concise directions**
  Directions must be written so that they can be followed by all students. Writing such directions requires clear objectives, a logical flow with transitions between steps and language that is simple and appropriate for students' age levels. Teacher questioning is an important mechanism for determining student problems, concerns, and misconceptions.

- **Are unbiased in terms of gender, race, religion or culture**
  Avoid using language that might be offensive to students based on their gender, ethnicity, socioeconomic status, religion, or other group-defining characteristics. Also, avoid using a context that might be unfamiliar to some of the students being assessed.

■ **Types of Assessment**

The STARS Toolkit uses six types of assessment as a framework for assessment design. The table below provides examples of assessments described in the toolkit. The examples provided for each type of assessment are not exhaustive. Teachers may wish to include additional examples of their own.

■ **Closed and Opened-ended Assessments:**

Closed assessments are questions or tasks that have one single, specific correct answer. Typically, selected response assessments are closed.

Open-ended assessments are questions or tasks that have many correct or excellent responses intended to promote thinking and application of ideas and information. There are no single, specific correct answers. Assessment types listed above may be either closed or open-ended.

On pages 13 and 14 are charts describing some advantages and disadvantages of closed and open-ended assessments.

Assessment Types with Examples

Selected Response	Constructed Response	Product	Performance	Observation	Interaction/Personal Communication
Multiple choice True/False Matching	Completion–fill-in Short Answer Label a Diagram Show Work Visual Representation Concept Map Semantic Web Chart Graph	Research Paper Project Report Exhibit Model Video Audiotape Multimedia Report Web Page	Oral Presentation Speech Demonstration Dramatic Reading Enactment Debate Multimedia Presentation Investigation Experiment	Anecdotal Records Checklist Informal Notes	Interview Oral Questioning Oral Discussion Think Aloud Learning Log Response Journal Conversations

Selected Response Assessments

■ **What are selected response assessments?**

Selected response assessments, also known as objective tests or forced-choice assessments, tend to be used to demonstrate mastery of factual information. However, it is possible to design selected response tests that measure more complex thinking. Three main selected-response format types are multiple choice, true/false, and matching.

Selected response assessments can sample mastery of knowledge and prerequisites skills for a performance or product. They can not tap the performance itself or assess the quality of the product. (Stiggins, 1997)

■ **What can these methods do?**

- Assess a large number of topics and ideas.
- Be scored objectively.
- Provide formative and summative information.
- Be easily understood by students and parents.

■ **Multiple Choice:** Multiple choice items include a question or an incomplete statement and a set of responses from which to choose. The item asks for the students to chose the "best" or correct choice to answer the question or complete the statement.

The main body of an multiple choice item is the stem. The stem may take the form of an incomplete statement or a direct question. Alternatives or options are the choices provided from which a student selects the best or correct answer. Distractors or choices which are the correct answer are also included.

In constructing multiple-choice stems, these guidelines should be considered:

- Use a concise, direct question that describes a single problem.
- Follow the rules of grammar.
- Highlight critical words such as *always* and *never*.
- Use negatively stated items only if absolutely necessary.

In constructing alternatives for multiple-choice items, these guidelines should be considered:

- Use alternatives that are plausible as a correct response.
- Avoid technical and unfamiliar phrasing.
- Have a clearly "best" answer.
- Make alternatives consistent in length, parallel, grammatically correct and correspond with stem.
- Use logical or numerical ordering when needed.

Mathematics Examples:
The mass of one liter of water is approximately _____.

a. 3 kilograms
b. 250 grams
c. 1000 grams
d. 1000 milligrams

The decimal equivalent of 3/8 is_____.

a. 250
b. .375
c. 425
d. .500

Reading/Writing Example:
Which word in the following sentence is used incorrectly?

There are twenty students in this class.

a. twenty
b. students
c. their
d. class

■ **True/False:** Students indicate whether statements are true or false. It is very tempting when constructing these items to focus on small factual details from the material that was covered in class or presented in the textbook. If these factual details are not critical to the primary intended achievement targets, then it would be inappropriate to include this information in an assessment.

In constructing true/false items, these guidelines should be considered:

· Avoid using trivial statements.
· Avoid using broad general statements.
· Avoid the use of negative statements.
· Avoid including two ideas in one statement.
· Create true statements and false statements that are approximately equal in length.
· Balance the number of true and false statements.
· If an opinion is expressed, attribute it to the source.

Mathematics Example:
True or False The diameter of a circle is 3 times the length of the radius.

Reading/Writing Example:
True or False The climax of a story is the turning point or key action that a character encounters.

- **Matching:** Matching items consist of two parallel lists of words or phases that require the student to match entries on one list with appropriate entries on the second list.

In constructing matching items, these guidelines should be considered:

- Use a homogeneous set of materials with all responses plausible for a given item.
- There should be an imperfect match between a number of items and responses in order to prevent students from simply using the process of elimination to determine the correct response.
- Include no more than *four to seven* items in each matching exercise.
- Arrange the responses in logical order if possible.
- Indicate in the directions the basis for matching.
- Place all of the items and responses on the same page.

Mathematics Example:
Match the following measurements to their appropriate labels.

____	volume	a. centimeters
____	surface area	b. square centimeters
____	perimeter	c. cubic centimeters

Reading/Writing Example:
Match the definitions to the appropriate term.

____	means the same	a. homophone
____	means the opposite	b. synonym
____	sounds the same	c. antonym
____	spelled the same,	d. homonym
____	pronounced differently	

Constructed Response Assessments

- **What are constructed response assessments?**
  Constructed response assessments are brief responses to open-ended or specific questions. Constructed response assessments include fill-ins, short answers, labeling a diagram, showing work, visual representations, webs, charts, and graphs.

Constructed response assessment can tap understanding of relationships among facts and knowledge and provide some insight into reasoning proficiency. They can assess the prerequisite knowledge and skills. They can also reveal gaps in understanding or student misconceptions.

■ **What can these methods do?**

- Stimulate student thinking and creativity.
- Provide a variety of assessment formats.
- Promote higher level thinking such as synthesis, analysis, and application.
- Provide a more in-depth assessment of specific topics and ideas.

■ **Fill-in:** Students supplies a word, a number or symbol in response to an incomplete sentence.

In constructing fill-in items, these guidelines should be considered:

- Reword statements so they do not come directly from the textbook.
- Word the statement in such a way that required answer is both brief and specific.
- Use blank spaces that are equal in length.
- Provide adequate space for answering the item.
- Limit the number of blank spaces in each statement.

Mathematics Example:
Complete the next two number is in the following pattern: 1, 4, 9, _____, _____, ...

A math problem that contains an equal sign is an example of a (an) _____.

■ **Reading/Writing Example:**
The name of the man who invented the steamboat is _____.

■ **Short Answer:** Students supply a word, phrase, a sentence(s) or draw a diagram or picture in response to a direct question.

In constructing short answer items, these guidelines should be considered:

- Use direct questions.
- Word the question in such a way that required answer is both brief and specific.
- When the required answer is to be expressed in numerical units, indicate the unit of measurement to be used and the number of significant digits to be retained.

Mathematics Example:
Milk sells for $0.96 a quart and $3.68 a gallon. How many cents would you save on each quart of milk if you bought it by the gallon? _____

Reading/Writing Example:
What is the relevance of *The Scarlet Letter* today?

- **Show Work:** Students show all the steps of a process or procedure in sequential order.

In constructing show work items, these guidelines should be considered:
- Provide enough room for students to show each necessary step.
- Make sure the question lends itself to showing sequential steps.

Mathematics Example:
Solve the following problem. Show your work by writing each step for all operations.

$2x + 3 + 5x = 11x - 5$

Reading/Writing Example:
Discuss the stages of the deterioration of the boy's society in *Lord of the Flies*.

- **Label a Diagram:** Students response to the parts of a diagram the teacher specifies for labeling.

In diagram items, these guidelines should be considered:
- Keep drawings simple, clear and neat.
- Directions are clear and concise on what is asked to be labeled.
- Provide enough room to place labels in the appropriate location.

Mathematics Example:
Draw and label the sides of the right triangle RST.

Reading/Writing Example:
Label the parts of the communication process.

- **Visual Representations:** Students explain or clarify with an illustration that helps organize their information visually. Webs, charts, graphs, time lines, Venn diagrams and character maps would be sample format types of visual representations.

Product Assessments

Product assessments allow students to demonstrate competence by creating tangible objects. To assess student achievement of some standards, teachers might examine and evaluate student-made products such as journals and logs, notebooks on particular topics, videotapes, audiotapes, multimedia presentations, computer demonstrations, bulletin boards, inventions, investigative

reports, mathematical models, essays, research papers, science projects, spreadsheets, web pages, and exhibits. Portfolios may also be thought of as products when they are designed to show evidence that a particular performance standard has been reached. Portfolios may also be used to organize and showcase multiple products students develop, providing teachers, students and parents with representative samples of students' overall achievement in a subject.

Performance Assessments

Performance assessments, as defined in this document, present students with tasks, projects, or investigations that culminate in student presentations. Teachers or other assessors observe students' presentations and use predetermined criteria to rate their performances. Performance assessments are often used in conjunction with product assessment, since students frequently present information about a product they have developed. Observation and interaction/personal communication assessments are also used frequently with performance assessments to evaluate processes students used as they developed their performances.

Examples of performance assessments include oral presentations, demonstrations, dramatic readings, reenactments, debates, multimedia presentations, and formal speeches.

Observation Assessments

Observation assessments include systematic documentation of student progress using checklists, anecdotal records of informal notes. Observation assessments are often used to provide documentation of student progress over time and to provide information about processes students use as they learn and demonstrate their new knowledge. Observations usually describe such things as students' attitudes, strengths, weaknesses, learning styles, skills, and strategies.

Examples of observation assessments include checklists, anecdotal records, and informal notes. A checklist is a record-keeping device teachers use to monitor specific student skills and behaviors. Anecdotal notes are developed when teachers or other assessors record and date brief comments related to specific student standards or goals. Informal notes are narrative records of insights and inferences teachers gather as they observe students over time.

Interaction/Personal Communication Assessments

Interaction and personal communication can be used as assessment tools. They are spoken or written dialogues between students and assessors for the purpose of determining students' thinking processes, although they may also be used to evaluate whether students arrive at an

appropriate answer to a problem or question. Interaction/personal communication assessments can also assess whether students make rote responses or incorporate new ideas into their own conceptual structures.

Examples of interaction/personal communication assessments include the following:

- *Interview*—formal and informal spoken or written exchange between teachers or assessors and students.
- *Oral questioning*—reflections and oral responses to activities and problems.
- *Think aloud*—verbalized thinking while performing a task.
- *Response journal*—written journal in which students respond, usually with structured assignments.
- *Conversations*—informal spoken exchanges about a specific topic.

Specific examples of selected response, constructed response, product, performance, observation, and interaction/personal communication assessments are provided in the mathematics and reading/writing assessment sections of this document.

The following assessment worksheet was used as a guide for teachers as they develop assessments to match specific standards.

Assessment Worksheet: Standard: _____

- **Develop clear achievement targets by unpacking the standard.**

Students know the following: (content)
Students can do the following: (processes)

- **Choose an assessment type that matches the achievement target.**
  (Note: Student portfolios may be used to collect and analyze samples of student work using many different type of assessments.)

Assessment Types	Selected Response	Constructed Response	Product	Performance	Observation	Interaction/Personal Communication
Examples	Multiple Choice True/False Matching	Completion (fill-in) Short Answer Label a Diagram Show Work Visual Representation Concept Map Semantic Web Chart Graph	Research Paper Project Report Exhibit Model Video Audiotape Multimedia Report Web Page	Oral Presentation Speech Demonstration Dramatic Reading Enactment Debate Multimedia Presentation Investigation Experiment	Anecdotal Records Checklist Informal Notes	Interview Oral Questioning Oral Discussion Think Aloud Learning Log Response Journal Conversations
Typical Achievement Targets	Knowledge	Knowledge	Skills & Processes	Skills & Processes	Skills & Processes	Skills & Processes

- **Locate or develop assessments that match the assessment type and achievement target.**
- **Develop scoring guides, rubrics, or cut-scores that identify levels of student performance (beginning, progressing, proficient, advanced).**

Open-ended Assessments

ELEMENTS	ADVANTAGES of Open-ended Assessment	DISADVANTAGES of Open-ended Assessment
Quantity	Fewer questions are used to provide an in-depth look at student knowledge and thinking skills.	More frequent, shorter forms of assessment are required.
Construction	Can be easily constructed.	Word choice is critical to obtain the information desired.
Administration Time	Potential flexibility with time and student interaction with assessor.	Test taking time varies tremendously and depends on nature and quantity of questions.
Scoring	Does not reward guessing.	May take longer time to evaluate due to variety of responses and formats.
Appropriateness	Format is familiar to many students. Supports a variety of learning styles such as visual, kinesthetic, auditory, etc.	May be dependent on the ability to read and write. Language proficiency influences responses.
Student-Input Interaction	Students are encouraged to be creative and to express their thoughts and interests.	Student answers may become lengthy and disjointed.
Implications for Curriculum	Focuses on understanding, application, and synthesis of knowledge. Encourages relevancy. Provides insights into student thinking.	Factual knowledge is not emphasized.
Alignment to Instruction	Reveal gaps in understanding and misconceptions which should be used to plan further instruction.	Time consuming especially when reteaching or refocusing is required.
Feedback	Feedback is individualized. Provides more specific feedback about individual strengths and weaknesses.	Meeting diverse student needs requires more teacher time and preparation.
Interpretation	Interpretation is student centered and reflects levels of student understanding of a topic.	Time consuming. Results cannot be easily summarized by a single score.

Closed Assessments

ELEMENTS	ADVANTAGES of Closed Assessment	DISADVANTAGES of Closed Assessment
Quantity	Assess large number of items in support of validity, reliability, and sampling issues.	Students may feel over whelmed with large number of items that may promote guessing.
Construction	Take relative little time to construct if commercially made products are used. Many commercially produced tests contain this type of assessment.	Difficult to construct good items. Can be time and labor intensive for teacher/district constructed tests.
Administration Time	May require shorter amounts of time to administer than other types of other assessment.	Time depends on nature and quantity of questions.
Scoring	Can be scored objectively using a machine or template.	Many times only a composite score is provided but no further analysis provided.
Appropriateness	Most older students have experience with tests, quizzes, homework or practice exercises. Require minimal directions for students to recognize and understand the expectations.	Primary age students with limited experience may have difficulty with assessment format. Language barriers, cultural influences, and use of various contexts can cause misinterpretation of question and responses.
Student-Input Interaction	Can involve students in generating questions and practicing self-assessment.	Limited opportunity for student creativity or expression of original thought.
Implications for Curriculum	Focus is on acquisition of facts, knowledge, and prerequisite skills.	Often not focused on understanding and application of concepts. May not be relevant to everyday problem solving.
Alignment to Instruction	Results guide reteaching and remediation by revealing common classroom mistakes.	Difficult to measure processes, critical thinking, creativity, oral communication or social skills of individuals.
Feedback	Provide immediate feedback for students, teachers, and parents.	Can be too narrow if used as the single assessment instrument.
Interpretation	Easily understood by students and parents.	May lead to the perception that more learning has occurred than actually has. Factual recall does not necessarily mean the student fully understands the concept.

Assessment Definitions

Accountability: Reporting a data-based summary of student learning to the public, including identification of system-wide strengths and weaknesses and specific plans for using the information to improve learning.	**Norm-Referenced Test:** A standardized assessment (in which all students perform under the same conditions) that compares student or group of students with a specified reference group, usually other of the same grade and age.
Analytical Trait Scoring: Scoring performance on several dimensions; giving more than one score.	**Open-ended:** A question or task that has many correct or excellent responses-intended to promote thinking and application of ideas and information. There is no single, specific correct answer.
Assessment: Systematically gathering information about student learning and using that information to communicate with students, parents, and others to improve learning and performance.	**Performance Assessment:** Assessment that is based on observation and judgement of student-created products and/or performances; intended to provide a rich portrait of student learning.
Closed: A question or task that has one single, specific correct answer.	**Performance Task:** Short- or long-term activities that include rich opportunities to learn and systematic opportunities to assess the quality of student work.
Constructed-Response Item: An assessment unit with directions, a question, or a problem that elicits a written or graphic response from a student.	**Personal Communication:** Using oral questions and student responses as opportunities for assessment; also includes interviews, examining student questions, and informal conversation.
Criteria The key qualities or dimensions of an effective performance.	**Reliability** The degree to which an assessment yields dependable and consistent results over repeated uses.
Criterion-Referenced Test: A standardized assessment (in which all students perform under the same conditions) that measures a student's performance according to specified standards or criteria rather than in comparison with the performances of other test takers.	**Rubric:** A guide for scoring student performance; sometimes includes descriptions of key characteristics of varying levels of performance.
Evaluation: Making judgements about student performance based on quality information gathered systematically over time.	**Selected-Response:** A question or task in which students must choose what they believe is the best or correct answer.
Holistic Scoring: Scoring performance as a whole; based on criteria but not giving feedback on specific qualities of the students work; giving a single score.	**Validity:** The ability of a test to measure what its authors or users intend it to measure.
Inter-Rater Reliability: The relabeled of scoring across raters. The most common measure of inter-rater reliability is the percent of exact agreements between two scores independently scoring the same set of papers.	

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The Nebraska Department of Education gratefully acknowledges the contributions of the following teachers who participated in the development of the reading/writing and mathematics portions of the toolkit.

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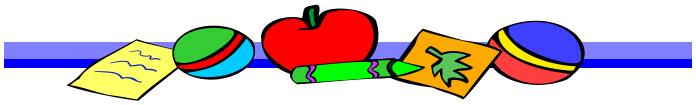
Multiple Classroom Assessments for Elementary School Mathematics



Numeration/Number Sense

4.1.2 By the end of fourth grade, students will represent numbers in equivalent forms.
Students have to demonstrate that they know the following content:

- Place value through the millions.
- Numbers written in expanded form.
- The base 10 system.
- Equivalencies.

Whole Numbers

Students can do the following:

- Demonstrate an understanding of equivalencies through expanded notation.
- Use base 10 manipulative to show understanding the concept of place value.

◆ Sample Assessment using whole numbers

Selected Response: Multiple Choice

1. Which choice is equal to 465?
   a. 4+6+5
   b. 40+60+5
   c. 400+60+5
   d. 600+40+5
2. Which number is equal to 1,000 + 300 + 40 + 5?
   a. 1,000,300,405
   b. 5,431
   c. 1,435
   d. 1,345
3. Which choice is equal to 23,409?
   a. 20,000+3,000+400+9
   b. 23+409
   c. 2,000+300+40+9
   d. 23,000+40+9

4. Which number is equal to (9*100,000) + (4*10,000) + (5*1,000) + (9*10) + (4*1)?
    a. 945,904
    b. 945,094
    c. 945,940
    d. 94,594

5. Which choice is equal to 7,296,401?
    a. 700,000 + 20,000 + 6,000 + 400 + 1
    b. 7 + 2 + 9 + 6 + 4 + 0 + 1
    c. 7,000,000 + 200,000 + 90,000 + 6,000 + 400 + 1
    d. 70,000 + 20,000 + 9,000 + 600 + 40 + 1

➢ Teacher Note
Students should know that * and x mean the operation of multiplication.

Constructed Response: Short Answer
Write the following numbers in expanded forms:

a. 23,458,965
b. 390,647,812
c. 642,000,873
d. 908,451,007
e. 98,498

➢ Teacher Note
Model of acceptable answer:
90,000+8,000+400+90+8=98,498 or
(9*10,000) + (8*1,000) + (4*100) + (9*10) + (8*1)

Write the following expanded form as a standard form.

a. 900,000,000 + 7,000 + 300 + 40 + 8
b. (9* 10,000,000) + (8*1,000,000) + (3*100,000) +(8*10,000) + (1*1,000) + (3*1)
c. 2,000,000 + 80,000 + 1,000 + 600 + 70 + 3
d. (9* 100,000) + (1*1,000) + (7*100) + (9*10) + (8*1)
e. 800,000,000 + 70,000,000 + 1,000,000 + 700,000 + 9,000 + 700

Interaction/Personal Communication: Interview or Response Journal
Using the base 10 system, explain how you would build a model:

a. 76,392 b. 21,564,927 c. 306,782 d. 111,749,005 e. 9,842

➢ Teacher Note
This could be accomplished in written form or in an interview with the assessor.

Numeration/Number Sense

4.1.2 By the end of fourth grade, students will represent numbers in equivalent forms.
Students have to demonstrate that they know the following content:

Fractions

- Equivalencies.
- Fractions.
- Decimals.
- The relationship between fractions and decimals.

Students can do the following:

- Represent equivalent fractions for common fractions with denominators of 2, 4, 5, 8, and 10 using concrete objects.
- Represent decimals for common fractions with denominators of 2, 4, 5, 8, and 10 using concrete objects.

◆ Sample Assessments using fractions

Products/Performances: Project

1. Using a 10 by 10 grid design a flag where 3/4 is red and 2/8 is blue. Describe the amount of the flag that is red and blue in decimal form.

2. Using a 10 by 10 grid design a flag where 5/10 is red and 2/5 is blue. Describe the amount of the flag that is red and blue in decimal form.

3. Using a 10 by 10 grid design a flag where ½ is red. Color the remaining sections using any other two colors. Describe colors of the flag in fraction and decimal form.

Products/Performances: Model

Using manipulatives show 2/3, then show that same amount as two equivalent fractions. Repeat the activity developing equivalent fractions for ½, 3/4, and 6/10.

➢ Teacher Note
A variety of shapes could be used to demonstrate the proportional awareness, e.g., rectangles, circles, etc.

Numeration/Number Sense

4.1.4 By the end of the fourth grade, students will identify and demonstrate positive and negative numbers and zero.

Students have to demonstrate that they know the following content:

- Positive numbers, negative numbers, and zero.
- Number line.

Students can do the following:

- Locate numbers on a number line.
- Move in a positive or negative direction on a number line.
- Use zero, positive, and negative numbers.

◆ Sample Assessments

Selected Response: Matching

Match the following to the correct letter above.

2 _____ -3 _____ -4

9 _____ -9 _____ 5

Constructed Response: Short Answer

Write a number representation using zero, positive, and negative numbers for the following statements:

Walk five steps forward.
Ran 7 blocks to school and walked 7 blocks back home.
Put a ten dollar bill in the bank.
Walked down 12 steps to the basement.

Performance: Investigation

1. Place the students in pairs.
2. Each pair has a number line labeled from -10 to +10 and one game marker.
3. Place the game marker at 0.

4. Students roll a number cube marked with positive and negative numbers. Each student rolls only 3 times per game.
5. At the end of the game, students state whether the number their marker landed on is above or below 0 and indicate if it is a positive or negative number.

Modeled after a game found in Houghton Mifflin Math Central 1999

Observation: Anecdotal Record/Informal Notes
The above game could also be used as an observation assessment. While students are involved in the activity, keep an anecdotal record or informal notes.

➢ Teacher Note
Clear criteria should be established in advance of the observations and shared with students.

Computation/Estimation

4.2.2 By the end of fourth grade, students will estimate and accurately calculate without and with calculators and solve problems involving addition and subtraction of decimals and understand the relationships among these two operations.

Students have to demonstrate that they know the following content:

- Estimation.
- Addition and subtraction facts.
- Column addition and subtraction involving decimals.

Students can do the following:

- Estimate decimal computations for reasonableness of answers.
- Add and subtract decimals.
- Solve problems of addition and subtraction involving decimals.
- Use a calculator to solve problems with decimals.
- Determine when a calculator is the appropriate tool to be used when doing computations involving decimals.

◆ Sample Assessments
Constructed Response: Short Answer
Compute the following:

a. 2.97 + 34.8 =
b. 6.5 - 3.87 =
c. 298.9 + 49.93 =
d. 10.425 - .983 =
e. 76.901 - 32.9 =

➢ Teacher Note
No calculators should be used.

Products/Performances: Project
Given a store receipt of at least 8 items with the total price removed, estimate and record the total bill by looking at the items purchased. Compute the total and compare to your estimation.

➢ Teacher Note
Option: Students may use the calculator to compute the total.

Constructed Response: Short Answer
Given an addition or subtraction equation using decimals, write a word problem to match this equation and solve.

➢ Teacher Note
Example: Teacher presents the equation: 1.50 - .75 =. The student then generates a word problem such as: "I had $1.50 in my allowance. I owed my sister $.75. How much money do I have left?" Calculator use is optional.

Interaction/Personal Communication: Oral Discussion
Explain how you can use addition to check a decimal subtraction problem.

➢ Teacher Note
Asking students to provide a rationale for their problem solving strategies is a great way to examine the depth of their understanding. Multiple questions may need to be developed to help students understand your expectations.

Computation/Estimation

4.2.3 By the end of the fourth grade, students will estimate and accurately calculate without and with calculators and solve problems involving addition and subtraction of fractions and understand the relationships among these two operations.

Students have to demonstrate that they know the following content:
- Numerator and denominator.
- Estimation.
- Addition and subtraction facts.

Students can do the following:

- Estimate fractional computations for reasonableness of answers.
- Add and subtract fractions.
- Solve problems of addition and subtraction involving fractions.
- Create equivalent fractions with like denominators.
- Use a calculator to solve problems with fractions.

◆ Sample Assessments

Selected Response: True/False

Circle the T for statements that are true and the F for statements that are false.

1. T F ½ + 1/3 = 1/5
2. T F 7/10 - 4/10 = 3/10
3. T F 3/4 - ½ = 2/4
4. T F 1/5 + 3/5 = 4/5

Circle the T for statements that are true and the F for statements that are false.

1. T F In the fraction 3/4, the 4 represents the denominator.
2. T F The fractions ½ and 5/10 are equivalent.
3. T F The numerator is the bottom number in a fraction.
4. T F The fraction 3/4 is larger than ½.

➢ Teacher Note

The true/false assessment can be improved. Ask the students to make the false statements true.

Constructed Response: Fill-In

Shade in the indicated number of shapes. Write the actual fraction for the shaded part in the blank.

1. Shade in 11 of these circles.
   O O O O O O
   O O O O O O
   O O O O O O Fraction: _____

2. Shade in 5 of these circles
   O O O O O O O O O
   O O O O O O O O O Fraction: _____

3. Shade in 9 of these diamonds.
   ♦ ♦ ♦ ♦ ♦ ♦ ♦
   ♦ ♦ ♦ ♦ ♦ ♦ ♦
   ♦ ♦ ♦ ♦ ♦ ♦ ♦ Fraction: _____

4. Shade in 6 of these rectangles.
   [] [] []
   [] [] []
   [] [] [] Fraction: _____

5. Shade in 2 of these rectangles.
   [] [] [] [] []
   [] [] [] [] []
   [] [] [] [] [] Fraction: _____

Constructed Response: Visual Representation
Use fraction strips to model and explain the following:

1. $\frac{1}{5} + \frac{2}{5}$ does not $= \frac{3}{10}$

2. $\frac{2}{4} + \frac{1}{3}$ does not $= \frac{3}{7}$

➢ Teacher Note
Provide students with a set of fraction strips and record their responses.

Interaction/Personal Communication: Interview
In an interview, have students explain a rule about how to add fractions with the same denominators and a rule about how to subtract fractions with the same denominators. Students may use pictures to help explain their rules.

Example: Subtract numerators and put the difference over the same denominator.

➢ Teacher Note
Interviews provide time for observation of students' thought process.

Measurement

4.3.1 By the end of fourth grade, students will estimate, measure, and solve problems using metric units for linear measure, area, mass/weight, and capacity.

Students have to demonstrate that they know the following content:

- Relationships among metric units of measure.
- Measure length to nearest meter or centimeter.
- Measure mass/weight to the nearest gram.
- Measure capacity to the nearest milliliter.
- Read temperature to the nearest degree using a Celsius thermometer.
- Calculate area.

Students can do the following:

- Use appropriate standard units of metric measure for linear measure such as centimeters and meters, weight/mass such as grams and kilograms, liquid capacity of milliliters and liters, and area such as square centimeters.
- Estimate, measure, and solve problems involving length, mass, weight, capacity, area, and temperature using measuring tools and real objects.

◆ Sample Assessments

Selected Response: Matching

Match the following measurement terms with the correct unit of measurement.

a.	Length	_____ cubic (centimeters, meters, millimeters, etc.)
b.	Area	_____ kilogram, milligram, gram
c.	Mass	_____ degrees Celsius
d.	Volume	_____ square (meters, centimeters, kilometers, etc.)
e.	Temperature	_____ centimeter, meter, kilometer

Products/Performances: Demonstration

Set up five centers with an object in each center that fits one of the five categories of metric measurement for example a box. Each center has a measuring tape, a gram scale, a thermometer, and milliliter measuring container available. The center has a question such as: What is the volume of the box? Using the correct tool(s) measure the object and record the measurement.

Observation: Checklist

You have three brands of paper towel (one being the school paper towel). You will devise an experiment to determine which paper towel is the most absorbent. Write a letter to the principal or custodian recommending a paper towel for school purchase.

Adapted from FOSS, Measurement module, Lawrence Hall of Science, University of California, Berkeley

Using a checklist, the teacher will observe the student's ability to choose the correct measurement tools and to measure accurately.

The checklist could include:

- Chose appropriate measurement tools.
- Chose an appropriate strategy.
- Measured and recorded data accurately.

➢ Teacher Note

This activity also provides an opportunity to integrate mathematics standards with the science and reading/writing standards. The teacher can observe the student's ability to:

- Drew logical conclusion based on the data.
- Wrote a letter that reported the results.

Measurement

4.3.2 By the end of fourth grade, students will estimate, measure, and solve problems using standard units for linear measure, area, mass/weight, and capacity.

Students have to demonstrate that they know the following content:

- Relationships among standard units of measure.
- Measure length to the nearest quarter inch, foot or yard.
- Measure mass/weight to the nearest ounce and pound.
- Measure capacity to the nearest fluid ounce.
- Calculate area.
- Read temperature accurately to the nearest degree using a Fahrenheit thermometer.

Students can do the following:

- Use appropriate standard units of standard measure for linear measure such as inch, foot or yard, weight/mass such as ounce and pound, liquid capacity of fluid ounce, and area such as square units.
- Estimate, measure, and solve problems involving length, mass, weight, capacity, area, and tempering using measuring tools and real objects.

◆ Sample Assessments

Constructed Responses: Graph matrix

Students are given index cards that contain individual measurement terms such as *inch*, *gram*, *milliliter*. Place each card in the appropriate place on the matrix by identifying the measure and determining the system it belongs to. Then, in each box of the matrix, arrange the cards from smallest to largest unit of measurement.

Sample Graph Matrix

Measures	Metric Unit	Standard Unit
Length(distance)	millimeter, centimeter, meter	
Mass		ounce, pound, ton
Volume(capacity)		

➢ Teacher Note

Previous measurement assessments can be adapted in both metric and standard units of measure.

Measurement

4.3.3 By the end of the fourth grade, students will tell correct time to the minute on an analog clock.

Students have to demonstrate that they know the following content:

- Parts of an analog clock (hands, markings, increments, numbers).
- Time by quarter hours and minutes.
- Count by fives and add on by ones.

Students can do the following:

- Read time on an analog clock.
- Move the hour hand (little hand) on a clock to represent the hour for a specific time.
- Move the minute hand (big hand) on a clock to represent the quarter hour or minute for a specific time.
- Count minutes on the clock.

◆ Sample Assessments

Constructed Response: Fill-In

Give students five to six analog clocks with preset times. Have students write the correct time under each clock.

Constructed Response: Short Answer

Solve the following problems:

1. Jenny started preparing lunch at 11:30 A.M. It was ready 20 minutes later. What time was lunch ready? _____

2. Paul helps his mother each Saturday. He begins his work at 8:45 A.M. and stops at 10:15 A.M. How long did Paul work?
   Paul works for _____ hour(s) and _____ minutes.

3. Imelda went to soccer practice at 4:05 P.M. and practiced 43 minutes. What time was practice over? _____

4. Write a story problem involving time to the nearest minute. Solve it.

Adapted from Columbus Public School District, Curriculum Assessment Book, Grade 4

Performance: Demonstration
Give each student a manipulative clock. Select times for the students to display on their clocks. Have students show the clock face to you when the time is set. Use the following rubric to determine mastery of telling time to the hour, half hour, quarter hour and minute.

Sample rubric:

Beginning.....Can move hour hand to represent hour
Progressing.....Can tell time and move hands on a clock to represent hour and half hour
Proficient.....Can tell time and move hands on a clock to represent time to the minute
Advanced .....Independently tells time and moves hands on a clock to represent time to the minute as well as tells time in two or more ways (20 till 5:00 or 4:40 or 40 minutes after 4:00)

Measurement

4.3.4 By the end of fourth grade, students will determine the perimeter of a many-sided figure (without a formula) using both standard and nonstandard units of measure, such as the six-sided figure measures 30 inches or 15 toothpicks around the edges.

Students have to demonstrate that they know the following content:

- Concept of perimeter.
- Definition of polygons.

Students can do the following:

- Measure the sides of polygons and add to determine the perimeter.
- Label the perimeter with the correct unit of measurement.
- Measure the perimeter of polygons using standard and nonstandard units.

◆ Sample Assessments

Constructed Response: Visual Representations

Measure the perimeter of each polygon with any tools available (straws, toothpicks, paper clips, string, rulers, and tape measures). Determine each polygon's correct perimeter.

➢ Teacher Note

Five to ten polygons are drawn large enough for students to measure accurately. Make sure to include regular polygons and irregular polygons for the students to measure.

Products/Performances: Investigation

Using graph paper, draw 5 or more polygons with a perimeter of 24 units.

➢ Teacher Note

Some students may choose to construct the polygons first using manipulatives.

Performance: Demonstration

Measure three teacher-selected items and one student-selected item in the classroom to determine perimeter. All four items will be measured using standards and nonstandard units.

➢ Teacher Note

A checklist will be used to determine that the student is competent in measuring and calculating perimeter.

Geometry/Spatial Concepts

4.4.1 By the end of fourth grade, students will identify, describe, and create two- and three-dimensional geometric shapes.

Students have to demonstrate that they know the following content:

- Geometric terms such as polygon, quadrilateral and congruent.
- The difference between 2-D and 3-D shapes.

Students can do the following:

- Create and identify 2-D shapes using concrete materials.
- Create and identify 3-D shapes using concrete materials.
- Describe characteristics of 2-D and 3-D shapes.
- Describe characteristics of 3-D shapes.
- Identify the 2-D shapes represented on the faces of 3-D objects.

◆ Sample Assessments

Selected Response: Matching

Match the 2-D shape with the correct characteristics.

____ triangle	a. A closed plain curve with every point the same distance from the center.
____ rectangle	b. A polygon with three sides.
____ circle	c. A quadrilateral with four right angles whose opposite sides are parallel.
____ square	d. A figure with four right angles and four equal sides.

Match the 3-D shape with the correct characteristics.

____ sphere	e. Pace or solid figure that has one circular base.
____ pyramid	f. A solid having six square faces the same size.
____ cone	g. A space or solid figure that has a polygon for base and has triangular faces that meet at a point.
____ cube	h. A solid figure that has a shape of a ball.

Product: Model

Students will create and identify 2 and 3 dimensional models. Models could be made from toothpicks, marshmallows, gumdrops, spaghetti, paper, straws, etc.

Examples:

Squares.....four marshmallows = 4 vertices or corners and four toothpicks = 4 sides.

Cubes.....eight gumdrops = 4 vertices or corners and twelve toothpicks = 12 edges.

➢ Teacher Note

Clear criteria should be established in advance and shared with students.

Interaction/Personal Communication: Response Journal

In a response journal, have students list, draw, or paste pictures of 5 real world examples of 2 dimensional shapes and 5 real world examples of 3 dimensional shapes. Have the students describe what makes each shape a 2-D or 3-D shape.

➢ Teacher Note

Rubric would need to be developed prior to assessment to evaluate student work.

Geometry/Spatial Concepts

4.4.2 By the end of fourth grade, students will identify and draw points, lines, line segments, rays, and angles.

Students have to demonstrate that they know the following content:

- Definition and properties of points, lines, line segments, rays and angles.
- Definition and properties of parallel and perpendicular lines and line segments.

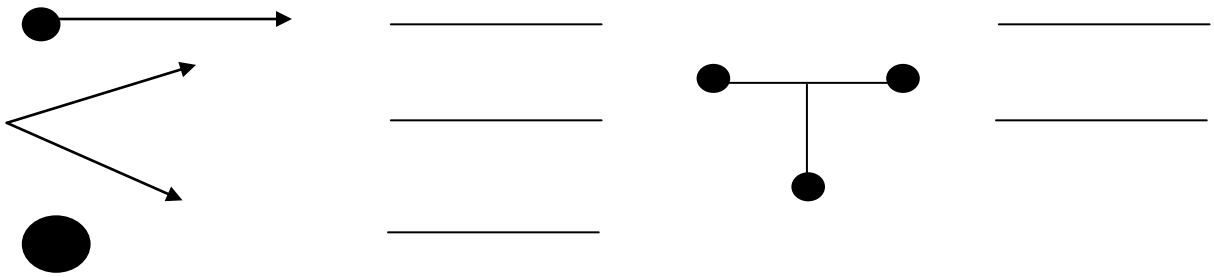
Students can do the following:

- Represent points, lines, line segments, rays and angles with drawings.
- Draw parallel lines and perpendicular lines.

◆ Sample Assessments

Constructed Response: Label the diagram

Label the diagram below identifying points, lines, line segments, rays, and angles



Products/Performances: Multimedia

Draw objects or find pictures that contain parallel lines and/or perpendicular lines and label lines.

(Examples: Door jam, rows of parallel lights, etc.)

➢ Teacher Note

Clear criteria of how many objects are desired and how these will be evaluated need to be determined prior to the activity and shared with the students.

Products/Performances: Oral Presentation

Challenge each student to create and model using their limbs to represent points, lines, line segments, rays, and angles and explain why each representation works for that geometric term.

➢ Teacher Note
Clear criteria of how many objects are desired and how these will be evaluated need to be determined prior to the activity and shared with the students.

Geometry/Spatial Concepts

4.4.3 By the end of the fourth grade, students will analyze, compare, and solve problems with geometric figures using congruence, symmetry, similarity, and simple transformations.

Students have to demonstrate that they know the following content:
- Congruence, symmetry, similarity, and simple transformations (slides, flips, and turns).
- Geometric shapes.

Students can do the following:
- Compare shapes to analyze if they are congruent or similar.
- Look at a figure with a line through it and determine if it is a line of symmetry.
- Determine simple transformations of pictures.

◆ Sample Assessments
Product: Model
Given a geoboard or attribute blocks, students will create or find two similar geometric shapes and two congruent geometric shapes.

For example: Similar shapes ..... big triangle and little triangle.
Congruent shapes ..... two squares exactly the same size.

Performance: Demonstration
Have students demonstrate simple transformations (slides, flips, and turns) on the overhead using various objects. Use checklist to determine mastery.

Student's Names	Slides	Flips	Turns	
				Key for checklist + = independently performs / = performs with assistance - = can not perform

➢ Teacher Note
You could also have students demonstrate using other objects within the room or a computer program.

Interaction/Personal Communication: Learning Log
In a learning log, have students find all of the letters of the alphabet that can show a line of symmetry. Have them list the letters and show the line of symmetry.

➢ Teacher Note
Students could choose 8 to 10 letters from the alphabet rather than all the letters. You could also use some real life objects instead of letters.

Algebraic Concepts

4.6.1 By the end of fourth grade, students will use and interpret variables, mathematical symbols and properties to write and simplify expressions and sentences.

Students have to demonstrate that they know the following content:
- Operational symbols and properties (i.e. +,-,=, /, *, ( ), etc.).
- Variables.
- Mathematical expressions and sentences.
- Order of operations.

Students can do the following:
- Solve various operations to find a missing variable (+,-,=,/,*,( ), etc.).
- Follow step-by-step procedures when solving number sentences.
- Write number sentences to solve for a missing variable.

◆ Sample Assessments
Selected Response: Multiple Choice
Circle the correct answer.

1. A pair of socks costs $4.00. If Ted buys 2 pairs of socks, which number sentence shows the total cost of both pairs?
   a. c = 4 * 2
   b. c = 4 - 2
   c. c = 4 / 2
   d. c = 4 + 2

2. A chair weighs 14 pounds. How much will 5 chairs weigh?
   a. 19 pounds
   b. 70 pounds
   c. 30 pounds
   d. 170 pounds

3. You have 48 cupcakes to share equally among 4 friends. Which number sentence represents how many cupcakes each friend will get?
   a. 48 + 4= n
   b. 48 - 4 = n
   c. 48 * 4 = n
   d. 48 / 4 = n

4. Jim puts 5 cars in each of 4 toy boxes. Lori puts 4 cars in each of 5 toy boxes. Juanita puts 10 cars in 2 toy boxes. Which person has more cars?
   a. Jim
   b. Lori
   c. Juanita
   d. They all have the same.

5. There are 36 students eating lunch in the cafeteria. Six students leave to work in the library. Which number sentence represents how many students are still eating lunch?
   a. S = 36 + 6
   b. S = 36 - 6
   c. S = 36 / 6
   d. S = 36 * 6

Constructed Response: Fill-In

Fill in the missing number to make a true statement.

1. 9 - _____ = 4

   24 = 4 * _____

   60 / 5 = _____ + 7

   7 + _____ = 13

   24 / _____ = 8

   3 * _____ = 36 / 4

   56 = 7 *

   9 * 8 + _____ = 78

Fill in the missing operation to make a true statement.

2. 9 _____ 3 = 6 - 3 6 * 3 = 9 _____ 2

16 _____ 8 = 4 * 2 24 _____ 4 =12 - 6

Interaction/Personal Communication: Learning Log
In a learning log have students write number sentences for given numbers. For example: The teacher gives the numbers 25 and 5. How many true number sentences can you make using the four operations? Answers could include the following:

5 + 25 = 30	5 + 20 = 25	25 - 5 = 20
25 / 5 = 5	5 * 5 = 25	25 - 20 = 5
25 / 5 + 5 = 10	25 + 5 * 4 = 45	(25 + 5) * 4 = 120

➢ Teacher Note
A rubric could be designed by the number and quality of answers given.

Sample rubric:

Beginning.....uses just two operations.
Progressing.....uses three to four operations with guidance.
Proficient.....uses all four operations.
Advanced .....uses all four operations with multiple steps.

Algebraic Concepts

4.6.2 By the end of fourth grade, students will identify, describe, and extend arithmetic patterns, using concrete materials and tables.

Students have to demonstrate that they know the following content:

- Concept of a pattern.

Students can do the following:

- Identify different patterns.
- Describe what is occurring in a given arithmetic pattern.
- Extend arithmetic patterns using concrete materials.
- Organize patterns into a table.

◆ Sample Assessments

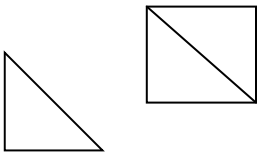
Constructed Response: Fill-in blank

Extend the pattern and describe the pattern for each set of numbers. (a calculator is optional)

a. 8, 16, 24, _____, _____, _____, Pattern _____
b. 10, 8,11, 9, _____, _____, _____, Pattern _____
c. 42, 36, 30, _____, _____, _____, Pattern _____
d. 50, 42, 35, 29, _____, _____, _____, Pattern _____
e. 2, 4, 8, 16, _____, _____, _____, Pattern _____

Constructed Response: Chart

It takes three toothpicks to make a triangle, and five toothpicks to make two triangles.



How many toothpicks would you need to make 8 triangles?

How many toothpicks would you need to make 85 triangles?

➢ Teacher Note

Students should be encouraged to use the strategy of using a chart.
An example would be:

Toothpicks	Triangles
3	1
5	2

Products/Performances: Model

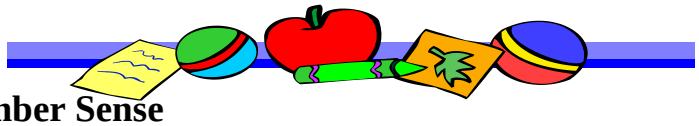
Given a set of four unifix cubes (1 blue, 3 orange). How many cubes would you use when building a pattern of 7 repetitions? Build a model with cubes or pictures.

Constructed Response: Chart

Given an in/out function box with three sample cards, identify and create a chart showing the pattern. Extend the pattern with three new pairs that follow the same pattern.

Example	In	Out
Card 1	1	8
Card 2	5	12
Card 3	9	16
Card 4		
Card 5		
Card 6		

Multiple Classroom Assessments for Middle School Mathematics



Numeration/Number Sense

8.1.1 By the end of eighth grade, students will recognize and utilize real numbers such as whole numbers, integers, and rational numbers.

Students have to demonstrate that they know the following content:

- Definitions of counting(natural), whole, integer, rational, and real numbers.

Students can do the following:

- Use the appropriate type of number in a given context.
- Identify the appropriate subset of a given number.

◆ Sample Assessments

Selected Response: Matching

Give students a folder with the definitions of whole numbers, integers, and rational numbers. Also contained in the folder are sticky notes with a number written on them. Students match the sticky notes to one of the appropriate definitions.

➢ Teacher Note

Some numbers can go in more than one category.

Constructed Response: Chart

Given the table, check **ALL** columns that are true for each number.

	Whole Number	Integer	Rational
1/2			
2 3/4			
2			
1.5			
-3			
5/3			

Evaluate student responses by giving the student a +1 for a correct response and a -1 for an incorrect response.

Interaction/Personal Communication: Informal Conversation
Pair students and assign them one of the three number sets. Each pair will describe properties of their set and provide at least two examples. Like pairs compile and present their descriptions to the entire class. The class discusses the differences between whole numbers, integers, and rational numbers and develops a summary of the basic properties of subsets of real numbers.

Evaluate by first determining your student expectations. Then create a check list to indicate progress towards these content and social skill goals. For this specific exercise the categories of mathematical concepts, mathematics communication and group work are appropriate. You might want to assess student ability to stay on task, listen, compromising, etc., to give correct examples and their knowledge of definitions and properties.

Numeration/Number Sense

8.1.2 By the end of eighth grade, students will apply relationships between fractions, decimals, and percents in a variety of situations.

Students have to demonstrate that they know the following content:
- Equivalencies of fractions, decimals, and percents.
- Relationships between fractions, decimals, and percents.
- Reading and writing of fractions, decimals, and percents.

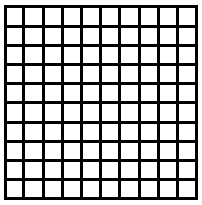
Students can do the following:
- Recall equivalent fractions/decimals/percents from memory. Example (fractions less than one with denominators 10 and less).
- Convert a fraction, a decimal, or a percent between the different forms.
- Express answers in simplest form.

◆ Sample Assessments
Constructed Response: Fill-in
Complete the following equivalences.

Fractions	Decimal	Percents
8/9	_____	_____
_____	1.2	_____
_____	_____	32.5%

➢ Teacher Note
You can include all the types of equivalences by choosing fractions, decimals, and percents.

Product: Model
Use 10 x 10 grids to shade each of the following:



.3	.01
3/4	1/5
.64	35%

➢ Teacher Note
Record number of correct responses.

Interaction/Personal Communication: Oral Questioning

- All note cards with equivalent fractions/decimals/percents are distributed randomly to the students leaving one card for the teacher to begin the activity.
- Length of time for student involvement can be increased by giving students 2-4 cards each.
- Teacher starts by reading the card with its value such as the fraction 3/4 then asks the class "Who has an equivalent decimal?"
- The student with the correct card responds by saying "I have the equivalent decimal of .75."
- The teacher will ask the class to verify the response.
- Other answers may be given if the first response is not correct.
- The student holding the correct card will ask the next question, specifying form of percent or using their other card and beginning a new set of fraction/decimal/percents.
- This process will continue until time runs out or all the cards have been used.

➢ Teacher Note
On three different note cards place ½, 50%, .5, continue with other examples. Use a checklist to record when individual students create equivalent fractions/decimals/percents.

Computation/Estimation

8.2.4 By the end of eighth grade, students will apply the order of operations to solve problems both with and without the use of technology.

Students have to demonstrate that they know the following content:

- Rules and uses of the order of operations.

Students can do the following:

- Perform operations (add, subtract, multiply, divide), exponents, and grouping symbols.
- Determine appropriate use of technology to solve order of operation problems.

◆ Sample Assessments

Selected Response: Fill-in

Answer the following:

	Without a Calculator	*With a Calculator*
$8 + (13-8) /5 =$	_____	_____
$(8 + 24) / (2 \times 8) =$	_____	_____
$8(2) – 3(8) / 6 =$	_____	_____
$(14 – 2^3) =$	_____	_____
$3^2 \times 2 + 5 =$	_____	_____

Discuss results and reasons for different answers. Write a paragraph describing how the order of operations works on their personal calculator.

➢ Teacher Note

Have students answer the questions without a calculator first. Then have the students use their own calculator and answer the same questions.

Constructed Response: Show Work

Show in separate steps how the order of operations rule should be used to simplify these problems.

$4 + 6 \times 2 - 1$	$7 + 3 \times 8 – 3^2$	$2 \times [2^2 + (3 + 1) / 2]$
Step 1 _____	Step 1 _____	Step 1 _____
Step 2 _____	Step 2 _____	Step 2 _____
Step 3 _____	Step 3 _____	Step 3 _____
	Step 4 _____	Step 4 _____
		Step 5_____

Answers:

Step 1 $\underline{4 + 12 - 1}$	Step 1 $\underline{7 + 3 \times 8 - 9}$	Step 1 $\underline{2 \times [2^2 + (4) / 2]}$
Step 2 $\underline{16 - 1}$	Step 2 $\underline{7 + 24 - 9}$	Step 2 $\underline{2 \times [4 + 4 / 2]}$
Step 3 $\underline{15}$	Step 3 $\underline{31 - 9}$	Step 3 $\underline{2 \times [4 + 2]}$
	Step 4 $\underline{22}$	Step 4 $\underline{2 \times [6]}$
		Step 5 $\underline{12}$

➢ Teacher Note

Rules and uses of the order of operations:

- 1st grouping with brackets, parentheses, etc.
- 2nd powers.
- 3rd multiply/divide from left to right.
- 4th add/subtract from left to right.

Consider using mnemonic device for remembering rules. For example - "**P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally," or have students create their own.

Performance: Investigations

Using two different calculators (scientific and non-scientific), show how different results are obtained on the same problem.

Solve using a calculator that does not perform order of operations.

$6 + 4 \times 2 =$ _____ $5 - 6 / 2 =$ _____ $(2 + 1 \times 2)^2 =$ _____

Solve using a calculator that performs order of operations.

$6 + 4 \times 2 =$ _____ $5 - 6 / 2 =$ _____ $(2 + 1 \times 2)^2 =$ _____

Explain why the two answers are different.
Tell which one is correct and why.

Computation/Estimation

8.2.5 By the end of eighth grade, students will apply strategies of estimation to a variety of problems both with and without the use of technology.

Students have to demonstrate that they know the following content:

- Rules of rounding numbers.
- Place value.
- Definition of compatible numbers.
- Strategies for estimation.

Students can do the following:

- Choose the appropriate estimation strategy.
- Apply the rules of rounding, appropriately in a variety of situations.
- Perform operations using technology.

◆ Sample Assessments

Selected Response: Multiple Choice

Using the rule of five for the tenth place, which of the following is the best estimate of 187.62:

a. 187
b. 187.6
c. 187.7
d. 190

Using rounding to the nearest whole number, which of the following is the best estimate of 187.62:

a. 187
b. 188
c. 190
d. 200

Using truncating, which of the following is the best estimate of 187.62:

a. 186
b. 187
c. 188
d. 189

➢ Teacher Note

- Rounding: estimate to the next specific place value
- Truncate: leave off the decimal part of a number
- Rule of five: if place value to the right is 5 or larger, round up; if smaller than drop off.

Interaction/Personal Communication: Journal or Interview
Have students respond to the following questions by recording answers in their journal or through an interview.

1. How do you know that $\sqrt{55}$ is close to 7.4?
2. Between which two consecutive whole numbers is $\sqrt{101}$?
3. How do you know?
4. What does "truncating" mean?
5. In what type of situation would you use rounding up? Why?

➢ Teacher Note
A rubric would need to be established and shared with students prior to the assignment.

Measurement

8.3.1 By the end of the eighth grade, students will select appropriate tools and properly measure quantities for temperature, time, money, length and width, area and perimeter, volume and capacity, weight and mass in both standard and metric units at the level of precision required.

Students have to demonstrate that they know the following content:

- Metric and standard system.
- Appropriate measurement tools for standard and metric measures.

Students can do the following:

- Select the correct measurement instrument.
- Use the measuring instrument correctly.
- Determine appropriate accuracy and precision for each measuring instrument.

◆ Sample Assessments
Selected Response: Matching
For problems 1-5, select the appropriate measurement tool. Each question has exactly one answer; however, an answer can be used more than once, or not at all.

____ 1. Salary of an employee	a. Ruler
____ 2. Height of a kitten	b. Thermometer
____ 3. Mass of a hamburger patty	c. Clock
____ 4. Time the tardy bell will ring	d. Measuring Cup
____ 5. Capacity of a pop can	e. Balance Scale
	f. Coins and Bills

For problems 6 –10, select the appropriate measurement tool. Each question has exactly one answer; however, an answer can be used more than once, or not at all.

____ 6. Measurements needed to find area of a stamp
____ 7. Body temperature
____ 8. Capacity of a carton of milk
____ 9. Mass of a can of peaches
____10. Distance around a track

g. Meter ruler
h. Balance Scale
i. Graduated Cylinder
j. Celsius Thermometer

Product/Performance: Research
Write a research paper on the history and development of standard and metric measurements. Divide the history of the various measurement systems and assign a specific time frame to each student.

The following sample rubric is a good model for student research. An additional rubric is needed to assess completeness and accuracy of paper.

Sample Rubrics

Criteria	Proficient	Basic	In Progress
Research	Independently demonstrates research skills using a variety of resources.	Demonstrates research skills with teacher/peer assistance.	Unable to demonstrate research skills.
Interpreting	Clearly and accurately selects and describes important information to make general conclusions or statements.	Accurately selects and describes important information to make general conclusions or statements with teacher/peer assistance.	Unable to select and describe important information to make general conclusions or statements.
Explaining	Independently explains interesting ideas or meanings from information.	Explains interesting ideas or meanings from information with teacher/peer assistance.	Unable to explain ideas or meanings from information.
General Conclusions	Independently formulates general conclusions from specific pieces of information or observations.	Formulates general conclusions from specific pieces of information or observations with teacher/peer assistance.	Unable to formulate general conclusions from specific pieces of information or observation.

Nebraska K-12 Mathematics/Science Frameworks, 1994

Constructed Response: Short Answer
Using your container filled with water or sand, do the following:

1. To a predetermined precision (nearest half inch, cm, etc.), record in a response journal:
   - Capacity, height (of the liquid), temperature, and weight obtained by using standard measurement tools.
2. Repeat using metric measurement tools.
3. Prepare a table of approximate equivalent standard and metric measurements obtained from your data.

Discuss results and create generalized statements indicating relationships between the two systems, such as a meter is approximately one yard.

➢ Teacher Note
Another assessment suggestion is to use the following rubric to evaluate processes used by students when measuring. This is a culminating assessment appropriate for the end of a measurement unit.

Measuring

Criteria	Proficient	Basic	In Progress
Measurement Tools	Can determine appropriate tool to use for measurement.	Can determine the appropriate tool to use most of the time.	Cannot determine the appropriate tool.
Read Measurements	Can accurately read measurement tool by increments to its significant digit.	Can accurately read measurement tool.	Cannot accurately read measurement tool.
Unit of Measure	Can determine appropriate unit of measurement to use.	Can determine the appropriate unit of measurement most of the time.	Cannot determine the appropriate unit of measurement.
Standard vs. Nonstandard	Can measure and/or estimate between standard and nonstandard units.	Uses limited estimation between standard and nonstandard units.	Unable to estimate between standard and nonstandard units.

Nebraska K-12 Mathematics/Science Frameworks, 1994

Measurement

8.3.2 By the end of eighth grade, students will convert units within measurement systems using proper conversion factors (standard and metric).

Students have to demonstrate that they know the following content:

- Standard and metric units of measurement.
- Relationships between measurements within each system.
- Relationship between distance, area, and volume.

Students can do the following:

- Convert within the measurement system.
- Cancel labels when converting measurements.
- Solve proportions.

◆ Sample Assessments

Selected Response: Fill in the Blank

State whether the statement is greater than, less than or equal to.

50 ft_____150 yds
18 yd ^{3}_____ 486 ft^3
48 oz_____ 4 lb
1760 yd_____ 1 mile
5 gal_____ 20 qt

Constructed Response: Chart

Complete the following chart for converting metric measurement.

mm	cm	m	km
			0.05
	320		
26000			
		190	
	0.4		

Product/Performance: Experiment

Experiment with Distance, Rate, and Time:

- Select a toy vehicle. Time the vehicle going a specified distance (in feet) using a stop watch.
- Record 3 trials, timing each, and averaging the outcomes.
- Using the formula distance = rate x time (d = rt), calculate the speed of the toy vehicle in feet per second and then convert to mile per hour.
- Using the formula given, use the average time to calculate the average speed in miles per hour.

➢ Teacher Note

Use the following checklist to assess student progress.

Demonstrates	Does Not Demonstrate	Behavior
		Procedure is written clearly so that it can be easily understood and followed.
		Records observations in a systematic manner.
		Data is complete and organized.
		Calculate speed.
		Convert speed to miles per hour.
		Calculate average speed in miles per hour.

Geometry/Spatial Concepts

8.4.1 By the end of eighth grade, students will identify, describe, compare, and classify geometric figures such as plane figures like polygons and circles; solid figures like prisms, pyramids, cones, spheres, and cylinders; and lines, line segments, rays, angles, parallel and perpendicular lines.

Students have to demonstrate that they know the following content:

- Names of plane and solid geometric figures and terminology for example faces, edges, vertices, radius, slant height, base, etc.
- Visual representation of geometric figures.
- Differences between lines, plane figures, and solids.

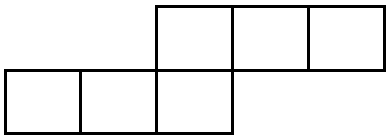
Students can do the following:

- Compare and contrast the characteristics of geometric figures and solids.

◆ Sample Assessments

Constructed Response: Visual Representation

Draw a net pattern for a given solid geometric figure.
This example is one possible net pattern for a cube.



➢ Teacher Note

Have geometric solids available to show the students.
Teacher could total acceptable patterns created and give a point total based on the following criteria:

- Student giving incorrect response (0 point).
- Student giving correct response (1 point).
- Student giving correct response and validate by drawing, etc. (2 points).

Product/Performance: Exhibit

Prepare an exhibit of geometric figures, giving the name of each figure and describe its characteristics. Group the figures and describe similarities.

➢ Teacher Note

The student's exhibit could be scored by a teacher checklist. The checklist should be given to students prior to the assignment. The checklist could include the following:

- Number of vertices.
- Number of segments.
- Number of faces.
- The names of the types of polygons that form the faces.
- List other names of polygons that would apply to an individual figure.
- Neatness/completeness/creativity.

Interaction/Personal Communication: Oral Discussion

Discuss how geometric shapes are used in traffic signs, computer flowcharts, architecture (walls and roofs, bridges), modern art, etc.

➢ Teacher Note

Teacher could record valid responses by students.

Geometry/Spatial Concepts

8.4.5 By the end of eighth grade, students will apply transformations to geometric figures such as translations or slides, rotations or turns, reflections or flips, and scale or dilate.

Students have to demonstrate that they know the following content:

- Transformation.
- Coordinate plane.

Students can do the following:

- Plot points on a coordinate system.
- Transform figures by translation, rotation, reflection, and scale.

◆ Sample Assessments

Selected Response: Multiple Choice.

Give students a geometric figure such as a rectangle with the following ordered pairs for its vertices (0,3), (4,3), (0,0), and (4,0).

1. Adding 4 to each x-coordinate of a geometric figure moves the figure _____.
   a. To the left 4 units.
   b. To the right 4 units.
   c. Up 4 units.
   d. Down 4 units.

2. Adding -2 to each x-coordinate of a geometric figure moves the figure _____.
   a. To the left 2 units.
   b. To the right 2 units.
   c. Up 2 units.
   d. Down 2 units**.**

3. Multiplying each x-coordinate of a geometric figure by 2 _____ the figure.
   a. Stretches the figure horizontally.
   b. Stretches the figure vertically.
   c. Shrinks the figure horizontally.
   d. Shrinks the figure vertically.

4. Multiplying each y-coordinate of a geometric figure by .3 _____ the figure.
   a. Stretches the figure horizontally.
   b. Stretches the figure vertically.
   c. Shrinks the figure horizontally.
   d. Shrinks the figure vertically.

5. Multiplying each x-coordinate of a geometric figure by 5/3 _____ the figure.
    a. Stretches the figure horizontally.
    b. Stretches the figure vertically.
    c. Shrinks the figure horizontally.
    d. Shrinks the figure vertically.

Product/Performance: Research Paper

Search the Internet for information on tessellation such as M.C. Escher, Kente Patterns, Native American Indian patterns, and American Quilt patterns. Print and present information you discovered, and provide a written summary focused on type of tessellations and possible applications to new situations.

➢ Teacher Note

An established rubric needs to be developed and shared with students prior to assessment. An example follows.

Criteria	Proficient	Basic	In Progress
Access Information	Gathers necessary information using a variety of methods and sources.	Gathers some information using a limited number of methods and sources.	Unable to gather information without assistance.
Interpret Information	Organizes information into a useful form.	Organizes data incompletely.	Cannot organize or interpret data.
Determine Possible Relationships	Correctly identifies relationships, recognizes connections, and synthesizes major ideas.	Able to identify most relationships but has difficulty connecting all ideas.	Does not correctly identify relationships. Cannot connect ideas.
Applications	Able to create parallel problems by varying conditions of original problems. Can apply ideas to new situations.	Able to create parallel problems. Unable to apply ideas to new situations.	Unable to apply to parallel problems.

Adapted from Nebraska Mathematics/Science Frameworks, 1994

Interaction/Personal Communication: Oral Discussion or Journal

PART I - Given the triangle formed by the points A= (1,2), B= (2,3), and C= (3,1).

1. Add 2 to each x-coordinate. Plot the three new points. What geometric transformation(s) took place?

2. Using the original triangle and coordinates, add -1 to the x-coordinate and describe what happens. Why did this happen?
3. Add 3 to the y-coordinate of the original triangle, and describe what happens. Why did this happen?
4. Multiply each x-coordinate of the original triangle by 4, and describe what happens. Why did this happen?
5. Multiply each x-coordinate of the original triangle by .5, and describe what happens. Why did this happen?

PART II - Given the square formed by the points A= (2,-2), B= (4,-2), C= (4,-4) and D= (2,-4).

1. Multiply each y-coordinate of the original square by 2, and describe what happens. Why did this happen?
2. Multiply each y-coordinate of the original square by .5, and describe what happens. Why did this happen?
3. Multiply each x-coordinate of the original square by -1, and describe what happens. Why did this happen?
4. Multiply each y-coordinate of the original square by -2, and describe what happens. Why did this happen?

Teacher Checklist

Yes or No, did the student appropriately identify each as a slide, turn, flip, or scale?

PART I	PART II
1.____	1.____
2.____	2.____
3.____	3.____
4.____	4.____
5.____	

Data Analysis, Probability, and Statistical Concepts

8.5.1 By the end of eighth grade, students will collect, analyze, interpret, and display data.

Students have to demonstrate that they know the following content:

- Mean, median, mode, range, upper and lower quartiles.
- Components of an appropriate survey question.
- Process of collecting and recording data.
- Forms for displaying data.

Students can do the following:

- Compute mean, median, mode, and range.
- Write a survey question, collect, and record data.
- Draw and label graphs, tables, and charts using technology or pencil and paper.
- Choose the appropriate type of graph for representing data.

◆ Sample Assessments

Product/Performance/Observation: Project/Oral Presentation/Checklist

- Design a survey question.
- Collect data, find appropriate measures like mean, mode, median, and range.
- Choose and create the best type of graph to display your findings.
- Use technology when appropriate.
- Present the display of data and an oral report to class.

Suggested checklist for scoring.

- The survey question is clearly written to yield a variety of numeric answers.
- The student has defined the group to be surveyed.
- The data has been tallied.
- The mean, median, mode, and range are computed correctly.
- The graph is drawn neatly and creatively.
- The graph is drawn correctly;
- Title appropriately.
- Both axes are labeled.
- Intervals are correct.
- Key is given, if needed.
- Data is correctly represented.
- The student is able to analyze and interpret results.
- The type of graph is appropriate for data.
- Technology was used correctly.

Data Analysis, Probability, and Statistical Concepts

8.5.3 By the end of eighth grade, students will conduct experiments or simulations to demonstrate an understanding of theoretical probability and relative frequency.

Students have to demonstrate that they know the following content:

- Definition of probability.
- Sampling techniques.

Students can do the following:

- Calculate probability.
- Calculate relative frequency.
- Predict outcomes based on the experiment.

◆ Sample Assessments

Product/Performance: Experiment

M&M Experiment found on pages 54-56, NCTM Addenda Series, grades 5-8, *Understanding Rational Numbers and Proportions*. Student will need to record their findings on Activity Sheet 4.1 (Individual Record Sheet), Activity Sheet 4.2 (Predicting from Data), and Activity Sheet 4.3 (Group Record Sheet).

Prior to assessment develop and share with students a rubric to assess the skill of relating probability to relative frequency. A good resource is the *Sample Rubric for Predicting* found in the Nebraska Mathematics/Science Framework document. (See Appendix D.)

Product/Performance: Experiment

Lucky Draw/Fund Raiser, Balanced Assessment, Task 4060 Simulation. Balanced Assessment for the *Mathematics Curriculum, Middle Grades Assessment*. Berkeley, Harvard, Michigan State, Shell Center. Package M2, Pre-publication Unit. Dale Seymour Publications. ISBN 0-7690-0068-1, Copyright 1999. An assessment rubric is included with the simulation.

Product/Performance: Essay

Rock/Paper/Scissors: Students play the rock/paper/scissors game. After playing the game, students analyze their choices and examine the probability for each. Assessment will consist of a one page word processed paper. In this paper the student will analyze his/her game and address the following questions:

a. Is this a fair game? Why or why not?
b. What is your prediction of the outcome if a third person is playing?
c. How could you change the game? Is it fair or unfair? Explain your reasoning.

Adapted from *Nebraska Mathematics/Science Frameworks* pg. c-8

Prior to assessment develop and share with students a rubric to assess the student's understanding of probability. A good resource is the *Sample Rubric for Predicting* and *Sample Rubric for Problem Solving* found in the Nebraska Mathematics/Science Framework document. (See Appendix D.)

Algebraic Concepts

8.6.1 By the end of eighth grade, students will demonstrate knowledge and use of the one and two dimensional coordinate systems.

Students have to demonstrate that they know the following content:

- Terms associated the with coordinate system: axis, origin, quadrant, ordered pair, etc.

Students can do the following:

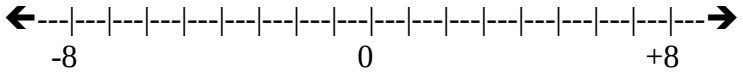
- Locate and label points on a number line and on a coordinate plane.
- Use inequality signs to express relationships between numbers.
- Evaluate a linear equation with two variables and generate a table of the results.

◆ Sample Assessments

Constructed Response: Charts

Locate the following real numbers on a number line and label each.

0, 6, -4, 1.75, -1 ½, -1/3



Then list the numbers in order from least to greatest._____

Constructed Response: Chart

- Complete the table for each graph.
- Graph each set of ordered pairs on a different plane.
- Use appropriate labels. (x-axis, y-axis, origin, quadrants, etc.)

X + Y = 6

X	Y
-3	
0	
1	
4	

X –Y = 5

X	Y
	-1
	0
	5
	1

Y = 4X

X	Y

Constructed Response: Graph
Graph the following ordered pairs on the coordinate plane below.
Label the X and Y axes.

(0, 4) (-4, 2) (-3, -2) (-2, 0) (3, 1)

Give the ordered pair for each of these points from the coordinate plane below.

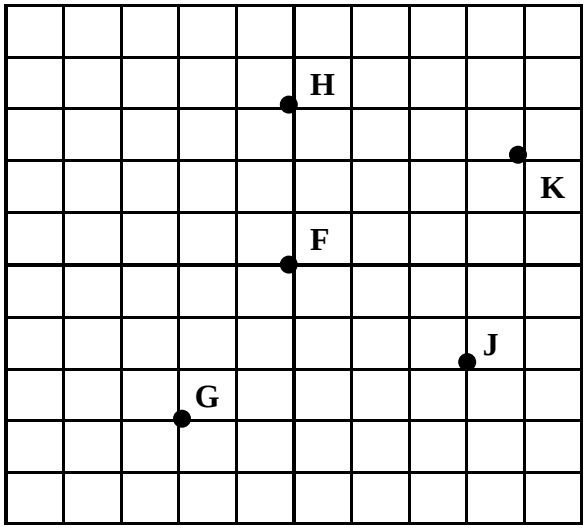
F_____

G_____

H_____

J_____

K_____



Algebraic Concepts

8.6.2 By the end of eighth grade, students will apply algebraic concepts and algebraic operations to solving problems.

Students have to demonstrate that they know the following content:

- Commutative properties of addition and multiplication.
- Associative property.
- Distributive property.
- Properties of addition and multiplication.
- Inverses of addition and multiplication.
- Multiplicative property of zero.
- Rules of order of operations.
- Algebraic expressions and equations.

Students can do the following:

- Apply the order of operations rules.
- Identify and apply the property used in each step.
- Write and evaluate algebraic expressions and equations.

◆ Sample Assessments

Selected Response: Matching

Part 1. Matching

____1. Commutative Property	a. 8x + 3 = 3 + 8x
____2. Associative Property	b. 3(x + 5) = 3x + 15
____3. Distributive Property	c. (5x + 3) + 2 = 5x + (3 + 2)
	d. 45 * 60 = 60 * 45

Part 2. Matching

____1. Identity Property	a. 0x = 0
____2. Inverse Property	b. 1x = x
____3. Zero Property	c. x + -x = 0
	d. 20 + 0 = 20
	e. 4 * 1/4 = 1

Constructed Response: Show Work

Solve the following, show all work, including a check.

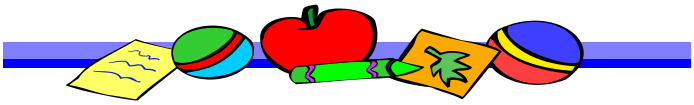
1. 3x + 7 = 22
2. 3x - 7 = 22
3. -3x + 7 = 22
4. -3x - 7 = 22
5. 5. 7 - 3x = 22
6. 3x + 7 = 22 - x *[Challenge Problem]*
7. 22 + x = -3x + 7 *[Challenge Problem]*

Interaction/Personal Communication: Oral Discussion

1. Simplify the following expression. (calculator/pencil and paper optional).
   - Defend your answer orally.
     (3 + 2) * 5 - 3 divided by 5^2 - (2 + 3) + 1

2. The student will (a) give an equation, (b) solve the equation, and (c) give a solution.
   - Bill has $4 and earns $8 each day he works. At the end of the week, he has $44. How many days did he work?

Multiple Classroom Assessments For High School Mathematics



Numeration/Number Sense

12.1.1 By the end of twelfth grade, students will describe and compare the relationships among all subsets of real numbers.

Students have to demonstrate that they know the following content:

- Subsets of real numbers: natural, whole, integers, rational, and irrational.

Students can do the following:

- Categorize numbers into different subsets.
- Cite multiple examples of each subset.

◆ Sample Assessments

Selected Response: True or False

Determine if the following statements are true or false. Correct the false statements.

T F 1. 6/7 is a rational number.
T F 2. 0 is a natural number.
T F 3. All whole numbers are rational numbers.
T F 4. -3/4 is an integer.
T F 5. All integers are whole numbers.
T F 6. 0.121121112... is rational.
T F 7. The $\sqrt{9}$ is irrational.
T F 8. 7 is a rational number.
T F 9. 0.333333... is rational.
T F 10. The rational and irrational numbers share a common set numbers.

Constructed Response: Fill In and Short Answer

Students should respond to the following questions.

1. Give an example of a natural number that is also a rational number.
2. Give an example of a rational number that is not an integer.
3. The number 7 is a member of which of the following subsets? (Check all that apply.)
   ___ Real ___ Irrational ___ Rational ___ Integers ___ Whole ___ Natural

4. The number 1/3 is a member of which of the following subsets? (Check all that apply.)
   ___ Real ___ Irrational ___ Rational ___ Integers ___ Whole ___ Natural
5. The number √2 is a member of which of the following subsets? (Check all that apply.)
   ___ Real ___ Irrational ___ Rational ___ Integers ___ Whole ___ Natural
6. Describe the numbers that are both whole numbers and rational numbers.
7. Is it possible for an integer to be an irrational number? Justify your answer.

➢ Teacher Note

Score student responses by giving +1 point for each correct check, -1 for each incorrect or missing check.

Products: Model

1. Construct a model (such as Venn diagrams, various sizes of paper bags, etc.) that shows the relationship between the following subsets of real numbers: natural, whole, integers, rational and irrational.

2. Place the following numbers in your model in the appropriate places:
   0, 2/3, -3, 5, √7, pi, √9, -8/3, .333333333..., .121232156432987..., -7/1

Assessment focuses on proper construction of the model. Proper construction requires that the 5 subsets of the real numbers and their relationships are represented. Also students must place all 11 numbers (found in number 2) in the appropriate subsets.

Computation/Estimation

2.2.2 By the end of twelfth grade, students will justify the reasonableness of solutions.

Students have to demonstrate that they know the following content:

- Place value.
- Estimation.
- Standard and Metric units of measure.

Students can do the following:

- Perform mental estimations.
- Demonstrate estimation strategies.
- Justify answers.

◆ Sample Assessments

Constructed Response: Short Answer

1. A store is having a Going Out of Business sale and all items are 98% off. Aaron says that a $129.95 jacket would now cost $2.60. Is he correct? Justify your answer.

2. A piece of carpet is purchased that is $80cm^2$. Will the rug cover more than half of the room that measures 10 feet x 15 feet? Explain your reasoning.

3. If you measure the side of your notebook paper, the unit of measure most likely would be?
   a. Millimeters b. Centimeters c. Meters d. Kilometers
   Explain your answer.

4. Your car gets 28 mpg in the city and 32 mpg on the highway. If you are traveling from Calgary to Winnipeg, Canada (approximately 1000 kilometers) and gas is $1.19 per liter, what would be a reasonable amount to budget for gas? Justify your thinking.

Product: Group Project

Mac's Burger Barn is located in a town of 5000 people. They only sell quarter pound hamburgers and cheeseburgers. There exists 3 competitive fast food restaurants. All the restaurants have a seating capacity of 50 and are staffed with 5-6 employees for each shift.

Estimate the number of hamburgers and cheeseburgers Mac's Burger Barn might sell in one week and defend your estimate.

Based on your estimation, answer the following questions: How many pounds of hamburger should you order? How many trays of buns should you order if there are 3 dozen buns per tray? How many pounds of cheese should you order if each slice weighs 5/8 oz.?

Prepare an oral presentation of your results for the class. Written documentation with all work shown is to be handed in to the teacher.

The assessment rubric should be developed and shared with students prior to assessment. It should include levels of proficiency in computation, justification of solution and organization of the presentation.

Interaction/Personal Communication: Response Journal

1. A news reporter said that 1.5 million people drank a total of 9.7 million gallons of water per day. Should you question this data? Justify your answer.

2. In the sports section, the following football statistics were posted. Determine if this information is reasonable. Explain your reasoning.

Team	*Wins*	*Losses*	*Win Percentage*
Iowa	9	3	.750
Grand Rapids 7	5	5	.583
Milwaukee	5	7	.417
Houston	4	8	.500

.

3. A poll was conducted on how teenagers spend a typical day and the results were tabulated.

Activity	*Percent*
Watching TV	32%
Eating	5%
Studying	5%
School Activities	22%
Sleeping	35%
Attending School	33%

If this information appeared in a newspaper, would you consider the results to be reasonable? Justify your answer.

Measurement

12.3.2 By the end of twelfth grade, students will convert between metric and standard units of measurement.

Students have to demonstrate that they know the following content:

- Equivalent ratios.
- Relationships within and between metric and standard measurement systems.

Students can do the following:

- Convert between metric and standard measurement systems.

◆ Sample Assessments

Constructed Response: Fill in

Given the table and formulas below, make the following conversions.

1 km ≈ 0.62 miles
1 kg ≈ 2.2 lbs
1 L ≈ 1.06 quarts
$^{o}C = 5/9 (^{o}F - 32)$
$^{o}F = 9/5^{o}C + 32$

1. 234 lbs ≈ _____ kg
2. 58 cm^2 ≈ _____ in^2
3. 4.5 L ≈ _____ qts
4. $78^{o}F$ ≈ _____ ^{o} C
5. 62 m ≈ _____ ft
6. 350 ml ≈ _____ ounces
7. 96 ft/min ≈ ____ m/sec

Product: Exhibit
Track events used to be measured in standard units, but are now measured in metric units because of international competitions.

Make a scale drawing showing a comparison of each pair of distances.

a. 100 yds and 100 m
b. 220 yds and 200 m
c. 440 yds and 400 m
d. 880 yds and 800 m
e. 1 mile and 1600 m
f. 2 miles and 3200 m

The assessment rubric should be developed and shared with students prior to assessment. It should include levels of proficiency in computation, justification of solution and organization of the presentation.

Interaction/Personal Communication: Response Journal
Respond to the following questions in your journal:

1. About how many cm are in an inch?

2. If someone enters a 10K run, approximately how many miles is this?

3. If it is 30^{o}C outside, what type of clothing should you be wearing when you go out?

4. If a punch bowl holds 2 gallons of liquid, approximately how many 2 liter bottles of pop should you purchase to fill it?

5. You are driving a 100 km per hour. If the speed limit is 55 mph, are you speeding?

6. Approximately how many square kilometers are in a square mile?

Geometry/Spatial Concepts

12.4.3 By the end of twelfth grade, students will analyze relationships among geometric forms.

Students have to demonstrate that they know the following content:

- Characteristics of two and three dimensional geometric figures.
- Formulas for perimeter, area, surface area, and volume.
- Transformations.
- Congruence and similarity.

Students can do the following:

- Calculate perimeter, area, surface area, and volume.
- Convert units of area and volume.
- Estimate perimeter, area, surface area, and volume.
- Determine how changing dimensions affects area and volume.

◆ Sample Assessments

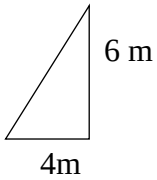
Selected Response: True or False

Mark each statement as true or false. Rewrite the false statements to make them true.

T F 1. When the length of a rectangle is doubled and the width is unchanged, the area is doubled.
T F 2. 15 m^3 is equal in volume to 15000 cm^3.
T F 3. 27 square feet is equal to 9 square yards.
T F 4. If each side of a cube is divided by 2, the volume of the cube is also divided by 2.
T F 5. If a cylinder is formed using a standard sheet of paper, the volume is the same whether you use the length or width of the paper as the height.
T F 6. 500,000 one-inch cubes would fit into a storage crate with dimensions 4' x 10' x 7.5'.
T F 7. If the length and width of a rectangle are doubled, the area is also doubled.

Constructed Response: Short Answer

1. Given the right triangle, describe what change(s) you would make in the dimension(s) to double the area.



2. Given a rectangle, describe what change(s) in its dimensions you would make in order to quadruple its area.

3. ☺ Given a sphere, describe the change in the volume if you divided the radius by 2.

4. Suppose you were given this piece of tin to make a cylinder.
What should the height of the cylinder be to obtain the greatest volume? *[Challenge Problem]*

5. Carl's Carpet is selling carpet for $11.99 per square yard. Ryan's Rugs is selling the same carpet for $2.99 per square foot. Which store should you buy your carpet from if you want the lowest price? Justify your answer.

6. A rectangular (non-square) piece of tin is used to make a cylinder. Should the circumference of the cylinder be the length or the width of the tin to get the greatest volume? Justify your answer. *[Challenge Problem]*

Performance: Demonstration

1. Draw two right triangles so that the second triangle has double the area of the first. Label all dimensions of both triangles. Describe what change(s) you made in the dimension(s) to double the area.

2. Build three cubes. Make the length of the side of the first cube no more than 5 units. Build a second cube by doubling the length of each side. Then build a third by doubling the sides of the second cube. Label all dimensions of three cubes. Describe what change(s) occurred in the volume of the cubes.

3. Construct two circles in which the area of one is 1/4 the area of the other. Label the radii. Describe what changes occurred in the radii and diameter of the circles.

Data Analysis, Probability, and Statistical Concepts

12.5.5 By the end of twelfth grade, students will formulate conclusions based on the interpretation of data represented by the normal distribution.

Student have to demonstrate that they know the following content:

- Normal distribution and percentiles.
- Mean and standard deviation.

Students can do the following:

- Locate the mean of a set of data.
- Read a stem and leaf plot.
- Use a table of values for the standard normal deviation to determine z-scores.
- Follow an algorithm.

◆ Sample Assessments

Selected Response: Multiple Choice

Using a standard normal distribution table, solve each of the following:
[Challenge Problems]

1. Find the probability that a randomly chosen observation from a standard normal distribution is less than the z score of 0.85. (See *Graph 1, Appendix A.)
   a. .1977 b. .3023 c. .8023 d. .0418

2. Find the probability that a randomly chosen observation from a standard normal distribution is between the z score of 0 and 0.85. (See *Graph 2, Appendix A.)
   a. .1977 b. .3023 c. .8023 d. .0418

3. Find the probability that a randomly chosen observation from a standard normal distribution is greater than the z score of -1.73. (See *Graph 3, Appendix A.)
   a. .9582 b. .8830 c. .3830 d. .4582

4. Find the probability that a randomly chosen observation from a standard normal distribution is between the z score of -0.5 and 0.5. (See *Graph 4, Appendix A.)
   a. .9582 b. .8830 c. .3830 d. .4582

5. About what percent of the data in a standard normal distribution are within one standard deviation of the mean? (See *Graph 5, Appendix A.)
   a. .6826 b. .1826 c. .9772 d. .4772

*****Problems and graphs adapted from *The University of Chicago Math Projects in Functions, Statistics and Trigonometry*, Second Addition, Scott Foresman, Addison Wesley, page 656-659

Constructed Response: Short answer

Using the given graph of the heights of adult American males in inches with a standard deviation of 3 and a standard normal distribution table, answer the following questions.
(See *Graph, Appendix B.)

1. What is the mean height?

2. What is the probability that the man is less than 6 ft tall?

3. Approximate the probability that the man is less than 64 inches tall.

4. Approximately what percent of men are at least 64 inches tall, but less than 76 inches tall?

5. What is the probability that a man is less than 64 inches or more than 76 inches tall?

*****Problems and graphs adapted from *The University of Chicago Math Projects in Functions, Statistics and Trigonometry*, Second Addition, Scott Foresman, Addison Wesley, page 663

Product: Project
Exploring Standard Deviation found on pages 68-69, NCTM Addenda Series, grades 5-8, *Dealing with Data and Chance*. Students will need to record their findings on the Black Line Masters 8 and 9.

➢ Teacher Note
A class discussion of similarities and differences among the sets of data and the statistical values will determine if students understand what standard deviation means. If a more formal assessment is desired, a rubric would need to be developed and shared with students prior to the assessment.

Algebraic Concepts

12.6.1 By the end of twelfth grade, students will interpret algebraic equations and inequalities graphically and describe geometric relationships algebraically.

Students have to demonstrate that they know the following content:
- Slope and intercepts.
- Slope-intercept form of a line.
- Properties within families of functions.

Students can do the following:
- Read and write equations and inequalities.
- Graph equations and inequalities.
- Analyze equations and inequalities.
- Compare relationships of slopes of lines.
- Analyze relationships within a family of equations.

◆ Sample Assessments
Selected Response: Matching
Match each equation with the appropriate graph.

Set I	Set II	Set III
___1. $y = 2x$	___1. $y = x$	___1. $y = x + 3$
___2. $y = (-1/3)x$	___2. $y = x^2$	___2. $y = 2x + 3$
___3. $y = (1/4)x$	___3. $y = x^3$	___3. $y = -2x + 3$
___4. $y = -5x$	___4. $y = \| x \|$	___4. $y = x - 3$
___5. $y = (½) x - 3$		

Set IV	Set V	Set VI
___1. $y = \| x \| + 3$	___1. $y < x$	___1. $y < x + 3$
___2. $y = \| x + 3 \|$	___2. $y > x$	___2. $y < -x - 4$
___3. $y = \| x \| - 7$	___3. $y \leq x$	___3. $y > x + 4$
4. $y = \| x - 3 \| - 7$	___4. $y \geq x$	___4. $y > -x - 3$
___5. $y = \| x + 3 \| + 4$		

➢ Teacher Note

Create graphs which would match the sets of given equations. Include one to two incorrect matches.

Constructed Response: Short answer

1. Identify the slope and y-intercept.
   a. $y = 2x + 3$ b. $3x - 5y = 10$

2. Write an equation of a line parallel to $y = 3x - 5$.

3. Write an equation of a line perpendicular to $y = 3x - 5$.

4. Graph the inequality: $y \geq 2x + 4$.

5. Explain how you determined which side of the line should be shaded.

6. What happens to the graph of $y = x$ when the equation is changed to $y = x + 2$? $y = x - 2$?

7. What happens to the graph of the equation of $y = x$ when it is changed to $y = (½)x$? $y = 2x$? $y = -3x$?

8. Compare the graphs of the equations $y = 4$ and $x = -3$. What is the slope of each line?

9. Compare the graph of $y = x^2$ with $y = -x^2$ and $y = 2x^2$. *[Challenge Problem]*

10. Compare the graph of $y = | x |$ and $y = | x + 2 |$ and $y = | x | + 2$.

Observation: Checklist

First: Students are given a grid and two pieces of linguini. The linguini (or thin spaghetti can be used) is used to form the graphs on the grid.

1.
a. $y = x$
b. $y = 2x$
c. $y = (-½)\ x$
d. $y = 3$
e. $y = -2$
f. $y = x + 4$
g. $y = 4x$
h. $y = 2x - 3$
i. $y \leq 2x - 3$

2.
a. $y = | x |$
b. $y = - | x |$
c. $y = | -x |$
d. $y = | x + 3|$
e. $y = | x | + 3$
f. $y = | x | - 2$
g. $y = | x - 2 |$
h. $y = | x + 3 | - 4$
i. $y = | x - 5 | + 6$

➢ Teacher Note

A checklist is used to assess student work.

Performance: Investigation

A good performance investigation is found in the Nebraska Math/Science Framework document. "If You Smoke, You Croak" Addendum Page L-48–52 can be assessed using either the checklist or a rubric. Both the checklist and rubric can be expanded to include additional categories for assessment. (See Appendix C.)

➢ Teacher Note

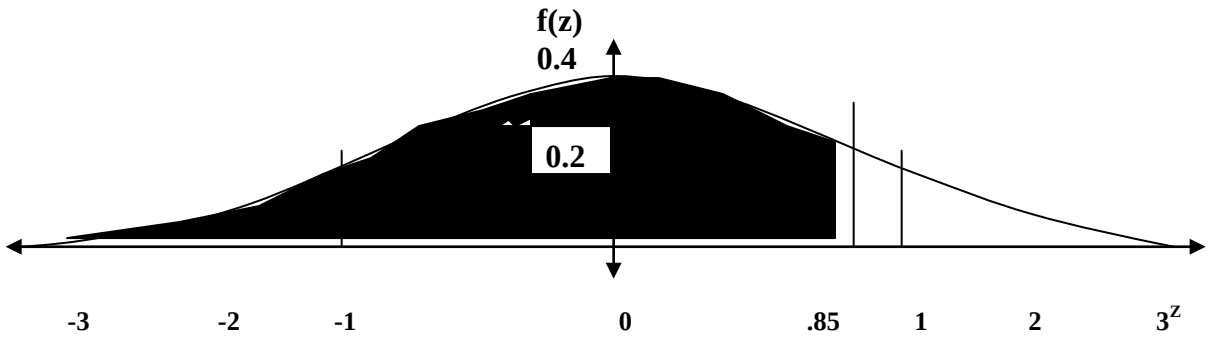
Other variables affecting lung capacity such as age, weight, amount of exercise, etc., can be discussed. Social-political issues may be addressed by further graphing investigating of the legal settlements from tobacco companies, medical costs related to smoking, and relationship life span and smoking.

➢ Teacher Note

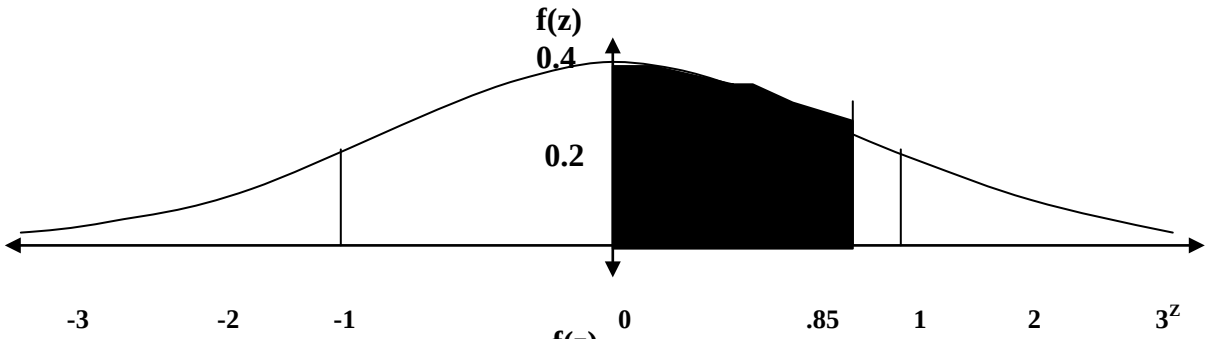
See Appendix D for Sample Rubrics of Process Skills from the Nebraska Mathematics/Science Frameworks document pages L-67 through L-76.

Appendix A

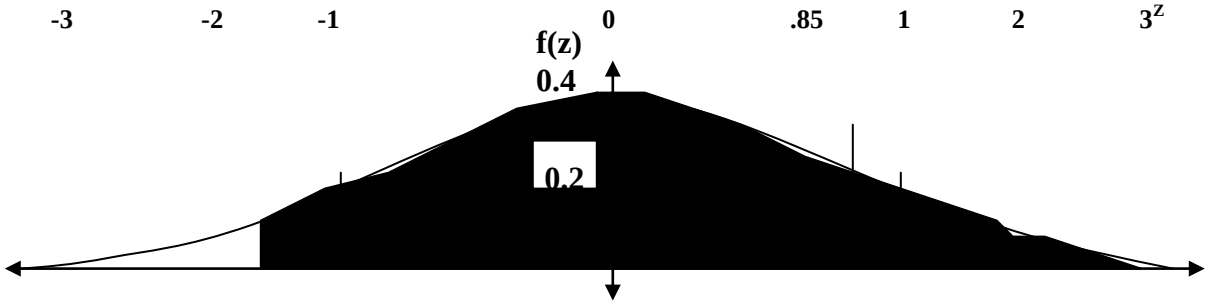
Graph #1



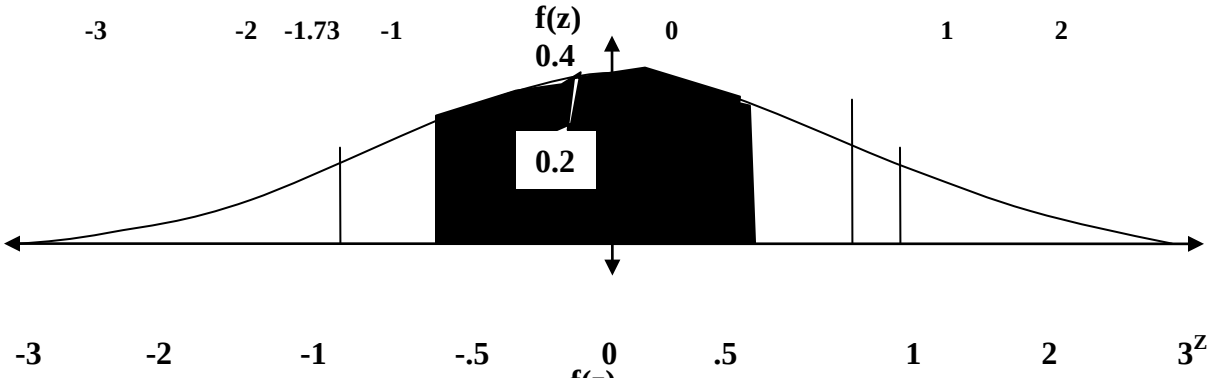
Graph #2



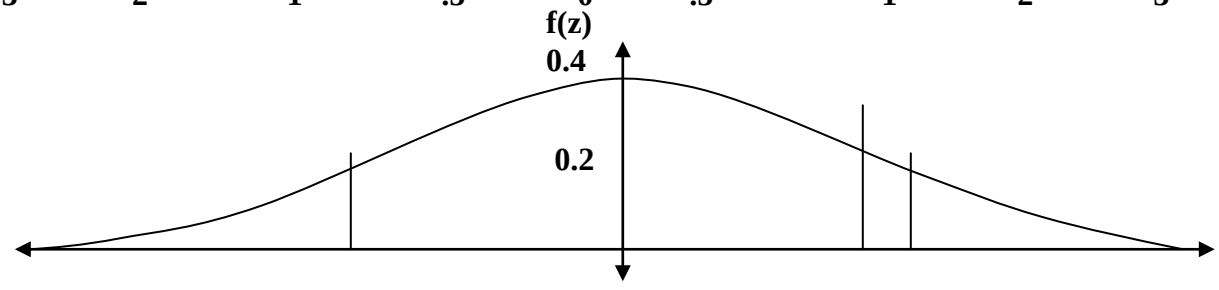
Graph #3



Graph #4

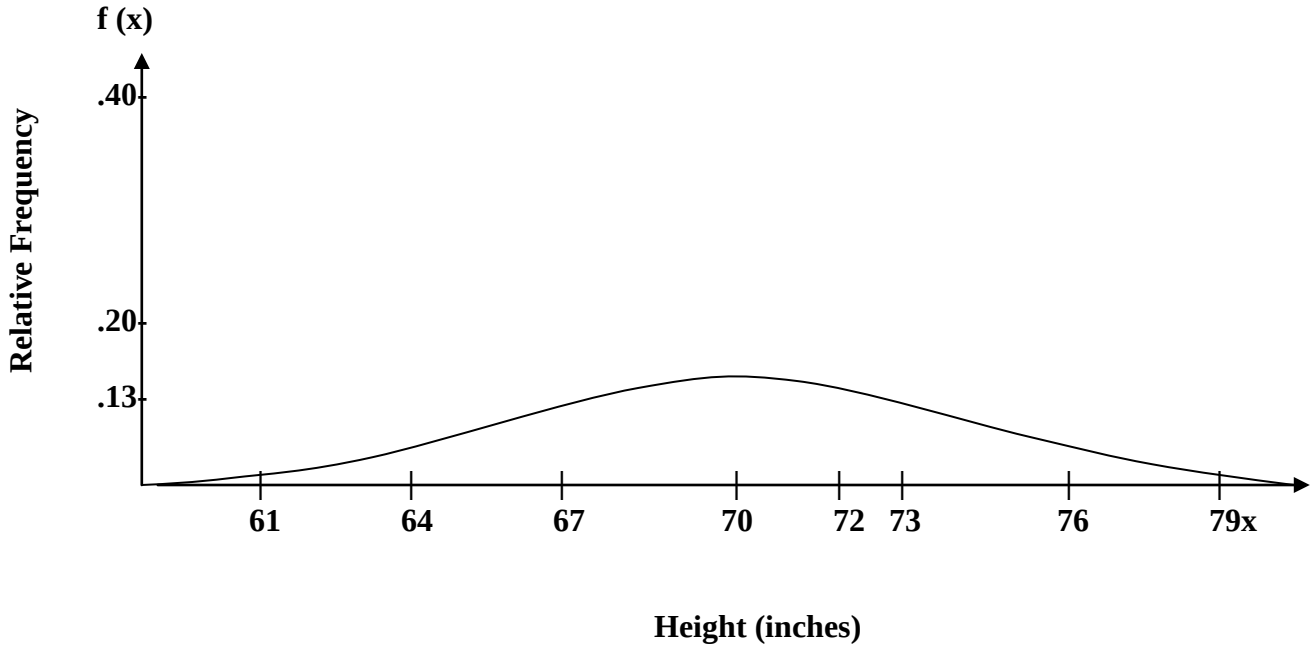


Graph # 5



Appendix B

[Heights of Adult American Males]



Appendix C

Nebraska Mathematics/Science Frameworks

"If You Smoke — You Croak."

Middle Level
Activity #3
L - 48-52

If You Smoke, You Croak – Middle Level #3

Materials/Supplies:	**Topic Strands:**	**Conceptual Threads:**
Balloons	Cells and Heredity	Systems and Interactions
Centimeter Tapes	Spatial Relationships	Connections
Liter Containers	Data Analysis	Technology
Non-smoking Posters	Algebraic Tops	Connections
Respiratory System Poster		

Process Skills of Learning:

Connection	Interpreting Data	Measuring
Modeling	Questioning	Reasoning

Why (Purpose/Objective of the lesson):

1. Te relate the volume of spheres to lung capacity.
2. To discover connections between algebraic concepts of slope, linear functions, and power functions; and the geometric concepts of circle, sphere, volume and pi.
3. To understand, interpret, and appreciate data discrepancies.
4. To investigate the effects of different variables on lung capacity.

How (Procedure of the lesson):

1. Arrange "No Smoking" posters in the room to stimulate student interest.
2. Examine animal lungs obtained at local meatpacking plant, butcher, or veterinarians.
3. Teacher records initial thoughts and comments from students about lung capacity and the effects of smoking.
4. Discuss and estimate the volume of one's lungs in liters.
5. Have students exhale normally and then force the residual volume out into a balloon. Have partners measure the circumference of the balloon and calculate its volume in cubic centimeters. Record three trials and average. Record on the classroom chart.
6. Have each student take the biggest breath and force all the air into the balloon. Measure the circumference of the balloon and calculate the volume in cubic centimeters. Record three trials and average. Record the average on the classroom chart.
7. Graph the results (diameter on x-axis and circumference of balloon on y-axis, or plot diameter of balloon on x-axis and volume on y-axis).
8. Have students calculate the mean, mode, and median for both total capacity and residual capacity.
9. Convert cubic centimeters to liters and compare to liter containers. Graph the volume versus the diameter.
10. Compare the results of smokers, to non-smokers, and asthmatics.

If You Smoke, You Croak – Middle Level #3

11. Debrief by discussing factors that can cause variability in data and how the experiment could be altered to minimize these kinds of errors.

12. Collect community data on the effects of the anti-smoking campaign, e.g., no-smoking areas, designated smoking areas, non-smoking lodging.

For Your Information (Background information for the lesson):
1. Use soft, easy-to-blow balloons.
2. Smoking statistics can be obtained from the American Cancer Society.
3. Facts you will need to know:
   a. The slope of the line for diameter versus circumference graph equals pi.
   b. The graph of volume versus diameter is a curved line.
   c. Conversion from cubic centimeters to liters is to divide by 1000.
4. Students with respiratory problems such as asthma must receive special consideration.
5. If you use the animal lung station, the activity should be prefaced by educating students that the lungs do not inflate by blowing air in. Due to the lack of a functioning diaphragm, lung inflation must be aided by pushing air into the lungs. Community connections to "Recussa Annie" can be made here.

Suggested Instructional Strategies:
Use cooperative learning to investigate and solve problems. If possible, lab stations could be set up and covered by mentor upper-level students.

Additional Activities (Extensions):
1. Discuss the minutes off one's life for each cigarette smoked. This ties in well with DARE Program.
2. A model of a lung machine makes a good anticipatory set. See diagram.
3. Research diseases that could affect lung capacity, such as stroke or heart attack.
4. Circumference can be measured with balloons filled with one breath, two breaths, three breaths.
5. Measure the time it takes for air to flow out of the balloon (flight time). Graph diameter versus flight time, or volume versus flight time. This works well with a unit on respiration. For instance, the importance of residual volume in life-threatening situations and CPR could be explored.
6. Current issues such as smokers' versus nonsmokers' rights, effect of environmental pollutants on breathing, and subsides to tobacco farmers (including historical, economic and cultural aspects) could be debated.

If You Smoke, You Croak – Middle Level #3

7. Research effects of exercise, smoking, age, sex, and second-hand smoke on lung capacity.
8. Research tobacco and its use in cultures and ceremony.
9. Do more statistical data analysis such as standard deviation and chi squire test.
10. Set up stations with pig lungs, videos and smoking, making lung machines from cups and balloons, etc.
11. Research well-known people who have died as a result of complications due to smoking.

Possible Assessment Ideas:

1. Observe involvement in group sharing of questions.
2. Examine graphs and classroom charts.
    a. Look at the graph of diameter versus circumference. The points form a straight line (note that (0,0) is a point on the line). The line serves as a guide to see if calculations were done correctly. Draw a line through the points or use best fit line on a calculator. The slope of the line will be close to pi.
    b. Look at the graph of a diameter versus volume. If residual volume was not used it looks like a straight line ((0,0) is a point on the curve). The curve looks like a parabola but is actually a cubic because radius is cubed.
3. Use the following checklist to measure students' understanding of lung capacity.

If You Smoke, You Croak – Middle Level #3

Checklist Item	Yes	No
1. Works well with partner all of the time.		
2. Can fully explain lung capacity.		
3. Can demonstrate how to measure lung capacity.		
4. Can calculate volume of balloon with east and 100% accuracy.		
5. Can fully explain effects of smoking or residual lung capacity.		
6. Can fully explain several ways disease affects lung capacity.		
7. Can calculate averages, means, and medians with 95% accuracy.		

Checklist Criteria

Criteria	Proficient	Basic	Needs Work
Cooperative Work	Works well with partner all of the time	Works well with partner more than half the time	Does not work well with partner
Understanding Total Residual Lung Capacity	Can explain fully lung capacity and demonstrate how to measure it using the balloon	Can give basic information on lung capacity and has some idea how to measure it using the balloon	Has difficulty explaining and/or measuring lung capacity
Mathematical Calculations Concerning Volume	Can complete problems for calculating volume of the balloon with ease and 100% accuracy	Can complete problems for calculating volume of the balloon with little help and at least 75% accuracy	Has difficulty completing problems for calculating volume of the balloon without help and/or is not at least 75% accurate in calculations
Understanding Effects of Smoking on Residual Lung Capacity	Can fully explain the effects of smoking on residual lung capacity	Can give very basic information about smoking and residual lung capacity	Has difficulty explaining any effects that smoking might have on lung capacity
Extending Learning to Things That Affect Lungs Other than Just Smoking	Can fully explain the way more than one disease affects lung capacity	Can give basic information on the way at least one disease affects lung capacity	Has difficulty explaining exactly how lung capacity is affected by other conditions
Other Mathematical Calculations	Can calculate averages, means, and medians with east and 95% accuracy	Can calculate averages, means, and medians with little help and at least 75% accuracy	Has difficulty calculating averages, means, and medians without aid or at 75% accuracy

If You Smoke, You Croak – Middle Level #3

Estimate the volume of each student's lungs in liters (think of a two-liter pop bottle).

Person 1 _____ Person 2 _____

Students will explore their lung volume. Each student will need a partner to fill in the following information.

	Record Circumference	**Record Flight Time**	**Calculate Diameter**	**Calculate Volume of Lung**
Residual Lung Volume				
Lung Volume				
Balloon with Two Breaths				
Balloon with Three Breaths				

Circumference is equal to diameter times pi.

Volume of a sphere is 4/3 times pi times radius to the third power.

Residual Volume-Exhale normally and then force the remaining air from your lungs into the balloon. Measure the circumference of the balloon using the tape measure (or strings).

Lung Volume-Take as large a breath as possible. Exhale as much air as possible into the balloon. Measure the circumference of the balloon using the tape measure.

Two Breaths-Fill the balloon with two breaths of air.

Flight time is measure from when the balloon is released until the balloon runs out of air (not necessarily when the balloon hits the floor). This may be enhanced by taping a straw on the opening of the balloon.

Graphing possibilities

1. Diameter versus Time
2. Circumference versus Diameter
3. Volume versus Diameter
4. Volume versus Time

12. Appendix D

Nebraska Mathematics/Science Frameworks

Sample Rubrics for Process Skills

Elementary Level
L - 67-72

Middle/Secondary Level
L - 73-76

Elementary Level – Sample Rubrics for Process Skills

Classifying

Criteria	Proficient	Basic	In Progress
Sort/Group	Recognizes and creates complex groups using more than one attribute; can classify more than one attribute at a time	Recognizes attributes and creates simple groups	Randomly manipulates objects; haphazardly sorts/groups
Matching	Identifies needed information; can see and explain connections	Can recognize similar attributes	Randomly manipulates objects/ makes matches haphazardly
Communication of Attributes	Communicates results clearly and logically; can communicate ideas in several forms (orally, in writing, drawings, graphs)	Can use simple explanations to communicate ideas	Cannon explain work or strategy adequately

Communicating

Criteria	Proficient	Basic	In Progress
Conveying Information	Can communicate ideas in three or more forms (orally, written, drawings, graphs)	Can communicate ideas in one or two forms (orally, written, drawings, graphs)	Difficulty in expressing ideas
Data Collection	Accurately and completely collects and organizes data	Collects and organizes data with some inaccuracy	Data not completely collected or is inaccurately organized
Explaining Thinking	Explains thinking process using details that explain or support the idea or topic; applies thinking process to make ideas clear or concise	May need assistance or prompts to explain thinking process; uses details that explain or support the idea or topic	Withdraws from discussion' unable to explain thinking process; no details to show understanding

Connections

Criteria	Proficient	Basic	In Progress
Extensions	Explores and relates ideas	Recognizes similar situations	No attempt to relate ideas
Application	Extends connections to "real" world	Makes connections to other subject matter	Cannot apply ideas

Elementary Level – Sample Rubrics for Process Skills

Interpreting Data

Criteria	Proficient	Basic	In Progress
Makes Inferences	Carefully considers all information; can analyze components; sees many connections within data	Does not consider all possibilities; examines components with some inferences; sees some connections with data	Draws minimal information from instruction; does not show initiative in analysis; recognizes few connections within data
Communicating	Designs tool for communicating; reports facts and insightful information	Conveys information by reporting basic facts	Rarely offers information; cannot design tool for conveying information
Drawing Conclusions	Interprets with clarity and creativity; shows initiative in summarizing; able to extrapolate beyond known data; makes highly accurate predictions; solutions are reasonable	Interprets information adequately; can draw some conclusions from data; unable to extrapolate beyond known data; uses good judgment for some predictions; solutions are reasonable with minimal flaws	May answer simple questions if prompted; makes faulty assumptions; cannot draw conclusions; makes faulty predictions, if at all; solutions are unreasonable

Measuring

Criteria	Proficient	Basic	In Progress
Uses Standard and Non-Standard Measurement with Accuracy	Able to measure using standard and non-standard units to fractional increments	Able to measure using standard and non-standard units	Unable to measure using standard and non-standard units
Selection/Use of Measuring Tool	Selects appropriate measurement units for task and demonstrates appropriate use of measurement equipment/tool	Can select measurement unit and use measurement took, but it is not the most appropriate unit or tool for the task	Recognizes differing measurement units but is unable to apply them appropriately to the tasks; can use measurement tool with assistance
Solves Problems Using Measurement	Develops procedures/formulas to solve problems related to measurement	Solves problems related to measurement`	Solves problems related to measurement with assistance

Elementary Level – Sample Rubrics for Process Skills

Criteria	Proficient	Basic	In Progress
Uses Senses	Uses all five senses interchangeably to gain information about objects or events; descriptively communicates information about all attributes/properties	Uses all five senses to gain information about objects or events; communicates information gained about some, but not all attributes/properties	Uses some of the five senses to gain information about objects or events; needs assistance communicating information gained
Applies Information	Identifies and compares attributes/properties of object or event in order to solve problems and extends this knowledge to other situations	Identifies and compares attributes/properties of object or event in order to solve problems	Identifies attributes/properties of object or event but needs assistance using this information to solve problems

Patterning

Criteria	Proficient	Basic	In Progress
Recognition	Recognizes complex patterns (AABAAB – AABAAB..)	Recognizes simple patterns (AB – AB – AB...)	Does not recognize patterns
Continue/Reproduce	Proposes and explores extensions	Makes connections and recognizes similar applications	Does not make connections to continue pattern
Communication	Communicates patterns clearly and effectively	Can support simple explanations of patterning	Cannot explain patterns

Elementary Level – Sample Rubrics for Process Skills

Predicting

Criteria	Proficient	Basic	In Progress
Uses Prior Knowledge	Applies relevant prior knowledge to new situations	Prompting or assistance needed to apply relevant prior knowledge to new situations	Unable to apply relevant prior knowledge to new situations
Forecasting	Uses inferences to make a specific prediction of what a future observation will be	Prompting or assistance needed to use inferences to make a specific prediction of what a future observation will be	Unable to use inferences to make a specific prediction of what a future observation will be

Problem Solving

Criteria	Proficient	Basic	In Progress
Clarifies the problem	Can restate or explain the problem coherently	Misinterprets or misunderstands part of the problem	Does not attempt the problem or misunderstands the problem
Formulates and Applies Strategies, Concepts, and Procedures	Knows and uses many strategies; generates new procedures	Knows and uses a limited number of strategies; can complete work in an acceptable manner	Makes no attempt to do the problem; cannot explain work or strategy adequately
Collects, Organizes, and Displays Data	Can collect and display data in an organized manner	Has minor flaws in collecting or displaying data	Makes no attempt or makes major mistakes in collecting or displaying data
Summarizes and interprets results	Draws valid conclusions/interpretations; makes sound generalizations	Summarizes and describes data appropriately; can generate/answer questions related to data	Makes no attempt to summarize or describe data
Communicates Results	Communicates clearly and effectively; explains thinking process well; can communicate ideas in several forms	Expresses ideas in simple form; can support simple explanations; uses some terms appropriately	Has difficulty communicating ideas; cannot bring thinking to conscious level; does not use or misuses terms; offers unrelated information

Elementary Level – Sample Rubrics for Process Skills

Hypothesizing – Upper Level

Criteria	Proficient	Basic	In Progress
Research	Independently demonstrates research skills using a variety of resources	Demonstrates research skills with teacher/peer assistance	Unable to demonstrate research skills
Observation	Independently demonstrates observation skills	Demonstrates observation skills with teacher/peer assistance	Unable to demonstrate observation skills
Questioning	Independently able to formulate pertinent questions reflecting higher-level thinking skills	Able to formulate pertinent questions with teacher/peer assistance	Unable to formulate questions
Inferences	Independently able to use content clues in making an inference	Makes inferences with teacher/peer assistance	Unable to demonstrate inference skills
Generalized Statements	Able to form a generalized statement based on research, observation, questions, and inference skills	Able to form a generalized statement with teacher/peer assistance	Unable to form a generalized statement

Inferences – Upper Level

Criteria	Proficient	Basic	In Progress
Interpreting	Clearly and accurately selects and describes important information to make general conclusions or statements	Accurately selects and describes important information to make general conclusions or statements with teacher/peer assistance	Unable to select and describe important information to make general conclusions or statements
Explaining	Independently explains interesting ideas or meanings from information	Explains interesting ideas or meanings from information with teacher/peer assistance	Unable to explain ideas or meanings from information
General Conclusions	Independently formulas general conclusions from specific pieces of information or observations	Formulates general conclusions from specific pieces of information or observations with teacher/peer assistance	Unable to formulate general conclusions from specific pieces of information or observation

Elementary Level – Sample Rubrics for Process Skills

Questioning – Upper Level

Criteria	Proficient	Basic	In Progress
Inquiring	Independently formulates logical questions based on facts, concepts, or principles	Formulates logical questions based on facts, concepts, or principles with teacher/peer assistance	Unable to formulate questions based on facts, concepts, or principles
Searching	Formulates questions that consistently interprets and synthesizes information gathered	Formulates questions that interprets and synthesizes information gathered with teacher/peer assistance	Unable to formulate questions through interpreting and synthesizing information gathered
Pertinent Information	Formulates questions paying close attention to detail when appropriate; checks information against all important sources and recognizes inaccuracies	Formulates questions paying adequate attention to detail when appropriate; checks information against all important sources, and recognizes inaccuracies with teacher/peer assistance	Unable to formulate questions using details; unable to check information against all important sources and to recognize inaccuracies

Middle/Secondary Level – Sample Rubrics for Process Skills

Classifying

Criteria	Proficient	Basic	In Progress
Determine Attributes of Groups	Is able to place in a hierarchy of groups	Is able to place in groups but in a random manner	Unable to place all items in groups
Label Groups	Is able to label groups appropriately	Is able to label groups appropriately most of the time	Is not able to label groups appropriately
Pattern Recognition	Notices patterns among objects and is able to extend pattern	Notices patterns among objects but is unable to extend	Unable to determine patterns

Communicating

Criteria	Proficient	Basic	In Progress
Expressing Ideas	Able to express abstract and concrete ideas clearly and concisely	Able to express ideas which can be clarified with few questions	Unable to express meaning of ideas to others
Organization	Presents ideas in sequential order	Presents most ideas in a sequential manner	Ideas are often out of sequence
Accuracy	Ideas and concepts contain no serious flaws	Ideas and concepts contain few minor flaws	Ideas and concepts contain few serious flaws
Models of Communication	Uses several modes to communicate ideas	Uses two modes of communication	One mode of communication used
Reasoning	Explains thinking processes well	Able to support simple explanations	Unable to verbalize thinking
Questioning	Responds to all questions and initiates questions	Has difficulty responding to or asking questions	Does not respond or ask questions

Middle/Secondary Level – Sample Rubrics for Process Skills

Connecting

Criteria	Proficient	Basic	In Progress
Technology	Uses appropriate/available technology effectively and correctly	Uses some technology in an acceptable way	Available technology not used
Integration Across Disciplines	Able to apply ideas to other disciplines	Able to sometimes apply ideas to other disciplines	Able to use ideas in a single discipline
Integration Within Disciplines	Proposes and explores extensions within disciplines	Able to recognize similar problems or applications within disciplines	Does not attempt to make connections within disciplines
Connecting to "Real" Life	Explores "real" life situations connecting many disciplines	Explores "real" life situations connecting some disciplines	Attempts but is unable to explore "real" life situations connecting other disciplines
Relationship	Relates objects, data, and procedures in one situation with real-life situations	Misses critical relationships between real-life situations	Identifies similar objects, data, or procedures but unable to connect to real-life situations

Hypothesizing

Criteria	Proficient	Basic	In Progress
Explains Inferences	Explains all inferences	Explains some inferences	Does not explain inferences
Explains Observations	Writes a statement based on many observable sources of information	Writes a statement based on some observable sources of information	Writes a statement not based on observable sources of information
Generalized Statement	Is able to write a generalized statement as a null hypothesis	Is able to write a generalized statement	Is unable to write a generalized statement

Inferring

Criteria	Proficient	Basic	In Progress
Makes Inferences	Able to accurately infer properties or occurrences about observations and/or data	Able to sometimes make an inference about properties of data and observations	Unable to accurately infer properties about observations and/or occurrences about data

Middle/Secondary Level – Sample Rubrics for Process Skills

Interpreting Data

Criteria	Proficient	Basic	In Progress
Draw Conclusions	Able to state a clear and accurate conclusion from data	Able to state a clear and accurate conclusion most of the time	Unable to make a clear conclusion
Read Data	Able to make interpretation of data and is aware of exceptions	Able to make interpretations but is not aware of exceptions	Unable to make interpretations and is unaware of exceptions

Measuring

Criteria	Proficient	Basic	In Progress
Measurement Tools	Can determine appropriate tool to use for measurement	Can determine the appropriate tool to use most of the time	Cannot determine the appropriate tool
Read Measurements	Can accurately read measurement tool by increments to its significant digit	Can accurately read measurement tool	Cannot accurately read measurement tool
Use of Measure	Can determine appropriate unit of measurement to use	Can determine the appropriate unit of measurement most of the time	Cannot determine the appropriate unit of measurement
Standard vs Nonstandard	Can measure and/or estimate between standard and nonstandard units	Uses limited estimation between standard and nonstandard units	Unable to estimate between standard and nonstandard units

Modeling

Criteria	Proficient	Basic	In Progress
Constructing a Model	Able to construct a model illustrating the concept and explain the relationship	Able to use a model illustrating the concept and explain the relationship	Unable to use a model or explain the relationship

Middle/Secondary Level – Sample Rubrics for Process Skills

Observing

Criteria	Proficient	Basic	In Progress
Observing	Methodically and thoroughly records observations	Records observations	Randomly records observations
Using Five Senses	Uses all five senses as appropriate	Uses most of the senses as appropriate	Uses one sense to gather information

Patterning

Criteria	Proficient	Basic	In Progress
Locating Patterns	Able to locate a repetitive pattern in many events or problems	Able to locate repetitive patterns in most events	Has difficulty locating patterns
Expressing Patterns	Expresses patterns using variables	Expresses patterns using examples	Unable to express patterns
Extending Patterns	Extends pattern to many other problems	Extends pattern to some other problems	Has difficulty using patterns in other problems
Applications	Able to create parallel problems by varying conditions of original problems. Can apply ideas to new situations	Able to create parallel problems. Unable to apply ideas to new situations	Unable to apply to parallel problems