Washington Comprehensive Assessment Program

Test and Item Specifications

Algebra 1

Office of Superintendent of Public Instruction
OSPI

The purpose of the end-of-course exams is to measure the level of mathematics proficiency that Washington students have achieved based on Washington State K-12 Mathematics Standards. In the 2008 revision, the Washington State K-12 Mathematics Standards are organized by areas of emphasis as: Core Content, Additional Key Content and Core Processes. Each area of emphasis has specific performance expectations.

Test and Item Specifications Algebra 1

Contents

Test Development Guidelines Algebra 1

The items on the Algebra 1 End-of-Course Exam reflect the performance expectations of the Washington State Mathematics Learning Standards. The guidelines in this document assist in writing items that match the performance expectations and their associated restrictions. Restrictions are necessary to construct a valid and reliable on-demand assessment. These restrictions are not necessary in classroom based assessments.

The item writer should be familiar with all item and rubric development guidelines listed in this section as well as specific considerations listed within each area of emphasis. A style guide determines the format of items and will be applied after the items are written.

Considerations and procedures that make item development more efficient and effective include, but are not limited to, the following guidelines.

Item Development Guidelines

Standards/Performance Expectations

- Students are expected to know all content, vocabulary, and processes in grades 3-8.
- An item may assess all or part of a performance expectation.
- An item may assess one or more performance expectations within a single area of emphasis.
- An item assessing Core Processes will use mathematics from the Core Content or Additional Key Content at the grade level being assessed.
- When applicable use stem, stimulus, and prompt rules for specific performance expectations found in each area of emphasis.

General Considerations

- Any contexts used in an item should be familiar to students.
- Stimulus content will be factually correct.
- Focus on what is essential and consequential to minimize the impact of, or need for, outside knowledge.
- Stimulus should <u>not</u> "trick" students into choosing or developing an incorrect or ineffective response.
- Items should avoid use of "not" or "if" unless it is essential to communicate understanding of the task. Consider substituting "when" for "if".
- Items will include language that is unbiased and that will not disadvantage a particular group of students.
- Items do not contain language or representations that might offend or demean any group of students.
- Character names will be assigned from a database that is representative of the range of ethnic diversity of Washington students.

- Manipulatives are not necessary for the exam but may be made available in the classroom.

Manipulatives and Tools Allowed	Manipulatives and Tools Not Allowed
Manipulatives that are used during the assessment should not be distributed to the students but should be available in the classroom to students who elect to use them. • Straightedge (all grades) • Ruler with centimeters and inches for grade 3 (required) • Protractor or angle ruler for grade 5 (required) • Compass for Year 2 EOC only • Abacus for visually impaired/blind students using Braille edition • Tiles, algebra tiles, cubes • Base-ten pieces • Pattern blocks, geoboards, Cuisenaire rods • Judy clocks without a digital display • Glossary of Non-Mathematics Terms • Graph paper for grades 3-8 only (must be collected and shredded) *Tools that can remain on teachers' walls:* • Hundreds charts (0-99 or 1-100 only) • Number lines with whole numbers only	Because of the multitude and variety of materials available, the following list of materials that are not allowed is not exhaustive. Consider all manipulatives "Not Allowed" if they are not listed as "Allowed". The following list addresses the most commonly asked questions concerning manipulative use from the field. • Calculators for grades 3-6 • Multiplication or addition matrices • Number lines with integers, fractions, decimals, or markings of multiples, prime, and/or composite numbers • Commercially- or student-made fraction pieces, fraction templates, or fraction materials, whether labeled or unlabeled • Dictionaries or thesauruses • Patty paper or tracing paper • Dry erase boards • Highlighters

- Calculators are allowed on the grade 7, 8, and end-of-course only. Please see the calculator policy at http://www.k12.wa.us/Mathematics/CalculatorPolicy.aspx.

Vocabulary/Context

Clear Language

- Item stems and stimulus materials should be straightforward and use simple syntax.
- Stimulus should be clear and simple with a minimum of distracting or irrelevant information unless it is appropriate for the performance expectation being assessed.
- The amount of reading should be kept to a minimum so that each item is clear and precise.
- Items will clearly indicate what is expected in a response to help students focus their responses.

Vocabulary

- Use vocabulary excel sheet located at http://www.k12.wa.us/Mathematics/TestItemSpec.aspx.
- Items use language targeted to the previous grade level or lower readability, except for required mathematics terms listed in the Test and Item Specifications document.

- Items will not assess vocabulary definitions or theorems directly, but will assess conceptual understanding and application.

Notational Considerations

- Numbers, other than years, having more than three digits to the left of the decimal point will include commas to group digits as in 435,000.
- Standard measurement abbreviations may be used; however, the unit should be spelled out if any confusion is possible, e.g., "inch" rather than "in."
- Letters used as variables are always italicized.
- The symbols "×" and "•" may be used to indicate multiplication.
- Parentheses or brackets may be used as grouping symbols to indicate multiplication.
- The symbol "÷" or a horizontal fraction bar may be used to indicate division.
- Fractions will have a horizontal line separating numerator and denominator, e.g., $\frac{1}{2}$.
- Large numbers may be represented with a heading labeled "in thousands" or "in millions" in tables, charts, or graphs.
- Decimals between negative one and one are written with a leading zero, e.g., 0.25 rather than .25.
- Illustrations of figures may include hash marks on line segments to indicate congruent sides.
- Right angles will be indicated in the graphics or item stem.
- The symbol "⊥" may be used to indicate perpendicular lines, e.g., $\ell_1 \perp \ell_2$ at grade 8 MSP and end-of-course exams.
- The symbol "$\|$" may be used to indicate parallel lines, e.g., $\ell_1 \parallel \ell_2$ at grade 8 MSP and end-of-course exams.
- Each graph or table will include a title in the prompt and/or the answer space.

Rules for Stimulus, Stem, and Prompt Content

- Stimulus content should be clear and simple with a minimum of distracting or irrelevant information unless it is appropriate for the performance expectation being assessed.
- Stimulus content should not "trick" students into choosing or developing an incorrect or ineffective response.
- Stimulus may include appropriate and relevant tables, charts, graphs, diagrams, and/or pictorial representations of objects, shapes, or figures.
- Items will focus on what is essential and consequential to minimize the impact of, or need for, outside knowledge.
- The amount of reading will be kept to a minimum so that each item is clear and precise.

Rules for Multiple-Choice Items

- Each Multiple-Choice item has four answer choices, the correct answer and three distractors (wrong answer choices).
- Each Multiple-Choice item will have a stem (question or statement).
- Multiple-Choice item stems will present a clear indication of what is required so that

students will know what to do before looking at the answer choices.

- The four answer choices will be approximately the same length, will have the same format, and will be syntactically and semantically parallel.
- The answer choices will be arranged in numerical or chronological order or according to length.
- Students should not be able to rule out a distractor or identify the answer simply because of superficial or trivial characteristics, syntactic complexity, or concept complexity.
- Distractors will reflect common errors or misunderstandings, naive pre-conceptions, or other misconceptions.
- Distractors will not be partially correct responses nor will they be designed to "trick" students into responding incorrectly.
- The responses "All of the above" and "None of the above" will not be used.
- The letters A, B, C, and D will be used for answer choices and will not be used as labels within a multiple-choice item in either upper or lower case.

Rules for Completion Items

- Completion items should be written like a multiple-choice item but no answer choices are provided.
- Completion items will give clear indications of what is required of students.
- Completion items will have a unique numeric answer or a number in a specified interval, i.e. answers derived using estimates of pi.
- Completion items will give a directive and reword the directive in the format of a question in the box with a line for the student's response. e.g. "Determine the quotient.", "What is the quotient?"
- Answer will not be scored for labels. Labels should be included in the question and/or answer space.

Rules for Short-Answer Items

- All EOC Short-Answer items assess content PEs in reporting strands used to calculate stu dent scores for purposes of meeting standard. Please refer to EOC Test Specifications for further information.
- Short-Answer items will give clear indications of what is required of students; e.g., "Name two properties of Figure A." or "Write an equation."
- Anything required by the scoring rubric will be asked for in the item.
- Item response spaces may be written to guide responses. A response that requires multiple parts may be scaffolded with boxes to draw attention to the parts.
- Directions with multiple requirements will be organized with bullets.
- When an item poses a specific question, the question is repeated at the bottom of the workspace with a line for the student's response.
- When an item gives a directive, then a question based on the directive will appear in the box with a line for the student's response. e.g. "Determine the surface area of the pyramid.", "What is the surface area of the pyramid?"

- General directions that allow the student to construct a response may read as follows: "Show your work using words, numbers and/or pictures." “Show the steps you used to solve the problem.”
- Any Short-Answer item that requires the student to use information from a stimulus will specifically ask for the information; e.g., “Use numbers from the table to …” or “Support your answer with information from the chart.”
- Short-Answer items may ask for a figure, diagram, equation, and/or a few sentences.
- Short Answer items will require a limited number of steps to develop a viable solution, demonstrate an understanding or process, communicate a mathematical idea or result, or show reasoning.
- Short-Answer items include Enhanced Multiple-Choice items that ask students to select from a list of four answer choices and then show work to support or explain the reason(s) for choosing that response.

Rules for Process Items

- The process PEs require a connecting content PE; e.g., 6.6.C (6.1.D). The 6.6.C indicates the item presents a sixth-grade problem-solving situation. The (6.1.D) indicates that multiplication and division of non-negative fractions is likely to be needed to solve the problem. EOC example of process PE; e.g., A1.8.B(A1.3.A)/M1.8.B(M1.2.A). The A1.8.B/M1.8.B indicates the item present an Algebra 1/Integrated Mathematics 1 problem solving situation. The A1.3.A/M1.2.A indicates that the content relates to functions and their characteristics.

Scoring Rubric Development Guidelines

- An item-specific scoring rubric will be developed for each Short-Answer item during the writing of the item.
- Short-Answer items will be scored with a 3-level scoring rubric (0-2).
- Score point elements will be based on the requirements of the item and its performance expectation(s).
- Scoring rubrics will focus on conceptual understanding, application of appropriate proce dures/strategies, and accuracy.
- Scoring rubrics will not consider conventions of writing (complete sentences, usage/gra mmar, spelling, capitals, punctuation, and paragraphing), as long as the wording of the r esponse does not interfere with the mathematical communication.
- Scoring rubrics that involve measured values will require students to label units when th e labels are not provided in the answer space.
- Scoring rubrics will be edited during pilot range finding.
- Scoring rubrics may be edited during operational range finding.

Cognitive Complexity

from Depth-of-Knowledge Levels for Four Content Areas, Norman L. Webb, March 28, 2002

"Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics a one-step, well-defined, and straight algorithmic procedure should be included at this lowest level. Other key words that signify a Level 1 include "identify," "recall," "recognize," "use," and "measure." Verbs such as "describe" and "explain" could be classified at different levels depending on what is to be described and explained.

"Level 2 (Skill/Concept) includes the engagement of some mental processing beyond a habitual response. A Level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include "classify," "organize," "estimate," "make observations," "collect and display data," and "compare data." These actions imply more than one step. … Caution is warranted in interpreting Level 2 as only skills because some reviewers will interpret skills very narrowly, as primarily numerical skills, and such interpretation excludes from this level other skills such as visualization skills and probability skills, which may be more complex simply because they are less common. Other Level 2 activities include explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

"Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is a Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems.

"Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking most likely over an extended period of time." (This level is best assessed at the classroom level and not relevant to this on-demand assessment.)

Algebra 1

A1.1. Core Content: *Solving Problems* *(Algebra)*
Students learn to solve many new types of problems in Algebra 1, and this first core content area highlights the types of problems students will be able to solve after they master the concepts and skills in this course. Students are introduced to several types of functions, including exponential and functions defined piecewise, and they spend considerable time with linear and quadratic functions. Each type of function included in Algebra I provides students a tool to solve yet another class of problems. They learn that specific functions model situations described in word problems, and so functions are used to solve various types of problems. The ability to determine functions and write equations that represent problems is an important mathematical skill in itself, Many problems that initially appear to be very different from each other can actually be represented by identical equations. Students encounter this important and unifying principle of algebra—that the same algebraic techniques can be applied to a wide variety of different situations.

A1.2. Core Content*: Numbers, expressions, and operations (Numbers, Operations, Algebra)*
Students see the number system extended to the real numbers represented by the number line. They work with integer exponents, scientific notation, and radicals, and use variables and expressions to solve problems from purely mathematical as well as applied contexts. They build on their understanding of computation using arithmetic operations and properties and expand this understanding to include the symbolic language of algebra. Students demonstrate this ability to write and manipulate a wide variety of algebraic expressions throughout high school mathematics as they apply algebraic procedures to solve problems.

A1.3. Core Content*: Characteristics and behaviors of functions* *(Algebra)*
Students formalize and deepen their understanding of functions, the defining characteristics and uses of functions, and the mathematical language used to describe functions. They learn that functions are often specified by an equation of the form $y = f(x)$, where any allowable x-value yields a unique y-value. While Algebra 1 has a particular focus on linear and quadratic equations and systems of equations, students also learn about exponential functions and those that can be defined piecewise, particularly step functions and functions that contain the absolute value of an expression. Students learn about the representations and basic transformations of these functions and the practical and mathematical limitations that must be considered when working with functions and when using functions to model situations.

A1.4. Core Content: *Linear functions, equations, and inequalities* *(Algebra)*
Students understand that linear functions can be used to model situations involving a constant rate of change. They build on the work done in middle school to solve sets of linear equations and inequalities in two variables, learning to interpret the intersection of the lines as the solution. While the focus is on solving equations, students also learn graphical and numerical methods for approximating solutions to equations. They use linear functions to analyze relationships, represent and model problems, and answer questions. These algebraic skills are applied in other Core Content areas across high school courses.

A1.5. Core Content*: Quadratic functions and equations* *(Algebra)*
Students study quadratic functions and their graphs, and solve quadratic equations with real roots in Algebra 1. They use quadratic functions to represent and model problems and answer questions in situations that are modeled by these functions. Students solve quadratic equations by factoring and computing with polynomials. The important mathematical technique of completing the square is developed enough so that the quadratic formula can be derived.

A1.6. Core Content: *Data and distributions* *(Data/Statistics/Probability)*
Students select mathematical models for data sets and use those models to represent, describe, and compare data sets. They analyze data to determine the relationship between two variables and make and defend appropriate predictions, conjectures, and generalizations. Students understand limitations of conclusions based on results of a study or experiment and recognize common misconceptions and misrepresentations in interpreting conclusions.

A1.7. Additional Key Content *(Algebra)*
Students develop a basic understanding of arithmetic and geometric sequences and of exponential functions, including their graphs and other representations. They use exponential functions to analyze relationships, represent and model problems, and answer questions in situations that are modeled by these nonlinear functions. Students learn graphical and numerical methods for approximating solutions to exponential equations. Students interpret the meaning of problem solutions and explain limitations related to solutions.

A1.8. Core Processes*: Reasoning, problem solving, and communication*
Students formalize the development of reasoning in Algebra 1 as they use algebra and the properties of number systems to develop valid mathematical arguments, make and prove conjectures, and find counterexamples to refute false statements, using correct mathematical language, terms, and symbols in all situations. They extend the problem-solving practices developed in earlier grades and apply them to more challenging problems, including problems related to mathematical and applied situations. Students formalize a coherent problem-solving process in which they analyze the situation to determine the question(s) to be answered, synthesize given information, and identify implicit and explicit assumptions that have been made. They examine their solution(s) to determine reasonableness, accuracy, and meaning in the context of the original problem. The mathematical thinking, reasoning, and problem-solving processes students learn in high school mathematics can be used throughout their lives as they deal with a world in which an increasing amount of information is presented in quantitative ways and more and more occupations and fields of study rely on mathematics.

Test Organization Algebra 1

The Algebra 1 End-of-Course Exam and Retake Year 1 will contain 37 items that assess the perfo rmance expectations common to Algebra 1/Integrated Mathematics 1. These items are used to determine a student's scale score for purposes of graduation. The performance expectations co mmon to Algebra 1/Integrated Mathematics 1 will be assessed using multiple-choice, completio n, and short-answer items on the end-of-course exams and retake exams.

In addition, the Algebra 1 End-of-Course Exam will contain 6 items that assess the performance expectations common to Algebra 1/Integrated Mathematics 2. These performance expectations are assessed and reported but are not incorporated into a student's scale score for purposes of graduation. These performance expectations will be assessed using multiple-choice and completion items on end-of-course exams only.

Multiple-Choice Items	Completion Items	Short-Answer Items
• Each Multiple-Choice ite m has four answer choic es, the correct answer a nd three distractors. • Multiple choice items ar e worth one point each. • There will be 29 Multipl e-Choice items assessing PEs common to Algebra 1/Integrated Mathemati cs 1. • There will be 3-5 Multipl e-Choice items assessing PEs common to Algebra 1/Integrated Mathemati cs 2. NOTE: Enhanced Multiple-Choice items are scored as Short-Answer items.	• Each Completion item re quires the student to en ter a numerical answer, an expression with varia bles, or an equation wit h variables. • Completion items are w orth one point each. • There will be 5 Completi on items assessing PEs c ommon to Algebra 1/Int egrated Mathematics 1. • There will be 1-3 Compl etion items assessing PE s common to Algebra 1/I ntegrated Mathematics 2.	• Each Short-Answer item requires a constructe d response. • A Short-Answer item may ask the student to write a sentence or equation; complete a tabl e, graph, or chart; draw a picture; construct a diagram; or perform a calculation. • An Enhanced Multiple-Choice item will ask th e student to select from a list of four answer c hoices and then show work to support or expl ain the reason(s) for choosing that answer or to solve a problem. No more than two items on a test will be Enhanced Multiple-Choice ite ms. • Short-Answer items are worth two points eac h. • There will be 3 Short-Answer items assessing PEs common to Algebra 1/Integrated Mathe matics 1. • Short-Answer items will not assess PEs comm on to Algebra 1/Integrated Mathematics 2.

The Algebra 1 End-of-Course Exam is intended to be administered to intact classrooms over three days.

OSPI's recommendations on administering the EOCs are as follows:

1. The EOCs should be given to intact classrooms over three days (30 minutes for directions/distributing materials, 120 minutes of testing time).
2. Students are expected to finish within 120 minutes of testing time.

Tools, including approved calculators, are allowed for the test administration. Please refer to t he calculator policy for more information.

Algebra 1 End-of-Course Test Map

Reporting Strands	Number of Items				Total Number of Points
	MC	CP	SA	Total	
Number, operations, expression and variables*	4-7	0-1	0-1	5-8	6-8
Linear equations and inequalities*	7-10	1-3	1-2	10-12	11-13
Characteristics and behaviors of linear and non-linear functions*	7-10	1-3	1-2	10-12	11-13
Data and statistics*	4-7	0	0-1	5-7	6-8
Total Number of Items used to determine scale score**	29	5	3	37	
Total Number of Points used to determine scale score**	29	5	6		40
Course-Specific content***	3-5	1-3	0	6	6
Total Number of Items				43	

**Items assessing these reporting strands assess performance expectations common to Algebra 1/Integrated Mathematics 1 and are used to calculate student scores for purposes of meeting standard.*

***A scale score on the end-of-course exam is used to determine a student's proficiency level: below basic, basic, proficient, advanced.*

****Items assessing course-specific content are in addition to the 37 items used to determine a student's scale score. Course-specific content items assess performance expectations common to Algebra 1/Integrated Mathematics 2. Student performance on these items is reported but is not incorporated into student scale scores for purposes of meeting standard.*

Algebra 1 Performance Expectations by Reporting Strand

Reporting Strands	Performance Expectations	
	Content	Process**
Number, operations, expression and variables	A1.2.A A1.2.B A1.2.C A1.7.D	A1.8.A A1.8.B A1.8.C A1.8.E A1.8.G
Linear equations and inequalities	A1.1.B A1.1.C A1.4.A A1.4.B A1.4.C A1.4.D	A1.8.A A1.8.B A1.8.C A1.8.E A1.8.G
Characteristics and behaviors of linear and non-linear functions	A1.1.A* A1.1.E* A1.3.A A1.3.B A1.3.C A1.4.E A1.7.A A1.7.B A1.7.C	A1.8.A A1.8.B A1.8.C A1.8.E A1.8.G
Data and statistics	A1.6.A A1.6.B A1.6.C A1.6.D A1.6.E	A1.8.A A1.8.B A1.8.C A1.8.E A1.8.G
Course-Specific content	A1.1.A* A1.1.D A1.1.E* A1.2.E A1.5.A A1.5.B A1.5.C A1.5.D	

A1.1.A and A1.1.E may include exponential functions that model growth or decay. Exponential growth aligns with Integrated Mathematics 1 and will be assessed in **Characteristics and behaviors of linear and non-linear functions. Exponential decay aligns with Integrated Mathematics 2 and will be assessed as **course-specific content.***

*** Items assessing process performance expectations (PEs) must include content at the Algebra 1 level. The content of items assessing process PEs determines its reporting strand.*

Item Specifications Algebra 1

Item specifications for each Area of Emphasis are organized in two sections:

Stimulus, Stem, and Prompt Rules

Stimulus, stem, and prompt rules list area-specific guidelines for developing items. The rules are in addition to those included in the Item Development Guidelines.

Content Expectations

The performance expectations in this document are identical to those in the Washington State Algebra 1 Mathematics Standards. Performance expectations that will be assessed at the state level appear in **bold text**. The remaining performance expectations, which appear in *italicized text*, should be taught and assessed at the classroom level.

Items assessing A1.8 Core Processes will use Core Content or Additional Key Content performance expectations from Algebra 1.

The information in the columns to the right of each performance expectation shows item development parameters for:

- Cognitive complexity (C.C.) as Level 1, Level 2, Level 3, or Level 4 as defined by Norman Webb.
- Format as Multiple-Choice (MC), Completion (CP), or Short-Answer (SA).
- Contextual Situation (Ctxt) as required (Y), item dependent (I), or not allowed (N).

A1.1 Core Content: Solving Problems

(Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.1 may expect students to define the variables used in an equation or inequality.
- Items assessing A1.1 may expect students to use a given function to solve the problem and interpret the solution in the context of the original situation.
- Items assessing A1.1 may expect students to represent a word problem as an equation, inequality, or system of equations or inequalities.
- Items assessing A1.1 may include step functions and those that contain the absolute value of an expression.
- Step functions will be described verbally or graphically, not symbolically.
- The absolute value of an expression will be represented in an equation, inequality, or graph.
- Short-Answer items assessing A1.1.A will include linear or exponential growth functions only.
- Multiple-choice items assessing A1.1.A may include linear, exponential, or quadratic functions.
- Items assessing A1.1.E will include functions of the form $y = ab^x$ where *b* may be less than 1.
- Items assessing A1.1.E may ask students to approximate solutions for *x* in the equation $y = ab^x$ and, when possible, give answers that are numerically exact.

Content Expectations

Items may ask students to:		*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.1.A	**Select and justify functions and equations to model and solve problems.**	**M1.1.A**	**M2.1.A**	2	MC,SA	Y
A1.1.B	**Solve problems that can be represented by linear functions, equations, and inequalities.**	**M1.1.B**		2	CP,SA	Y
A1.1.C	**Solve problems that can be represented by a system of two linear equations or inequalities.**	**M1.1.C**		2	CP,SA	Y
A1.1.D	**Solve problems that can be represented by quadratic functions and equations.**		**M2.1.C**	2	CP	Y
A1.1.E	**Solve problems that can be represented by exponential functions and equations.**	**M1.1.D**	**M2.1.D**	2	MC,CP	Y

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for italicized text
Ctxt=Contextual Situation ***I***= Item dependent ***Y***= Yes Context ***N***= No Context

A1.2 Core Content: Numbers, expressions, and operations

(Numbers, Operations, Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Real numbers include those written in scientific notation or expressed as fractions, deci mals, exponentials, or roots.
- Expressions may include radicals, absolute values, and integer exponents.
- Algebraic properties include the identity, zero, commutative, associative, and distributiv e properties.
- Items assessing A1.2 may expect students to write algebraic expressions in equivalent fo rms using algebraic properties and to perform the four arithmetic operations with polyn omials.
- Items assessing A1.2.C may ask students to write an answer in simplest radical form.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.2.A *Know the relationship between real numbers and the number line, and* **compare and order real numbers with and without the number line.**	**M1.6.A**		1	MC	I
A1.2.B *Recognize the multiple uses of variables,* **determine all possible values of variables that satisfy prescribed conditions, and evaluate algebraic expressions that involve variables.**	**M1.6.C**		1,(*2*)	MC,CP	N
A1.2.C Interpret and use integer exponents and square and cube roots, and apply the laws and properties of exponents to simplify and evaluate exponential expressions.	**M1.7.C**		1	MC,CP	N
A1.2.D *Determine whether approximations or exact values of real numbers are appropriate, depending on the context, and justify the selection.*	M1.6.B		(*2,3*)	NA	NA
A1.2.E Use algebraic properties to factor and combine like terms in polynomials.		**M2.5.A**	1	MC	N
A1.2.F *Add, subtract, multiply, and divide polynomials.*		M3.6.C	(*1*)	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for italicized text
Ctxt=Contextual Situation ***I***= Item dependent ***Y***= Yes Context ***N***= No Context

A1.3 Core Content: Characteristics and behaviors of functions

(Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.3 may include linear, quadratic, exponential, step functions and thos e that contain the absolute value of an expression.
- Items assessing A1.3 may expect students to understand $f(x) = \frac{a}{x}$ represents an inverse v ariation.
- Items assessing A1.3 may include equations involving square and cube roots, absolute v alues, or exponents.
- Items assessing A1.3.A may expect students to describe further restrictions on the doma in of a function appropriate for a given problem situation.
- Items assessing A1.3.B will use at least two of the four representations (expression, grap h, table, or in words).
- Items assessing A1.3.C may represent a function as an equation, table, graph, or in word s.
- Items may present the range or domain of a function symbolically ($x > 3$) or in words ("a ll real numbers greater than 3"). Items will not use interval [-3, 4) or set notation $\{x|x \leq 4\}$.
- Items may present relationships as an equation or inequality; in a chart, table, or graph; or in words.
- Step functions will be described verbally or graphically, not symbolically.
- The absolute value of an expression will be represented in an equation, inequality, or gr aph.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.3.A Determine whether a relationship is a function and identify the domain, range, roots, and independent and dependent variables.	**M1.2.A**		1,2	MC,SA	I
A1.3.B Represent a function with a symbolic expression, as a graph, in a table, and using words, and make connections among these representations.	**M1.2.B**		2	MC,SA	I
A1.3.C Evaluate *f*(*x*) at a (i.e., *f*(*a*)) and solve for *x* in the equation *f*(*x*) = *b*.	**M1.2.C**		1	MC,CP	N

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for italicized text
Ctxt=Contextual Situation ***I***= Item dependent ***Y***= Yes Context ***N***= No Context

A1.4 Core Content: Linear functions, equations, and inequalities

(Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.4.A may include the absolute value of an expression.
- Items assessing A1.4.A may expect students to identify the solution to inequalities on a number line.
- Items assessing A1.4.A may include compound inequalities.
- Items assessing A1.4.B may present an equation of a line in standard form, point-slope f orm, or slope-intercept form.
- Answer choices will all be presented in the same form (standard, point-slope, or slope-in tercept).
- Intercepts will be represented with ordered pairs, (x,y).
- Items assessing A1.4.D may expect students to solve symbolic problems using a variety o f methods (addition, subtraction, substitution) and understand that the solution to a sys tem of equations is given by the coordinates of the intersection of the two lines and the solution set to a system of inequalities is a region of the coordinate plane when the lines are graphed in the same coordinate plane.
- Items assessing A1.4.D may ask students to determine the value of one or both variables in the solution to the system.
- Items assessing A1.4.D may include a blank grid; only the answer choice (Multiple-Choic e Items) or the student answer (Completion Items) is scored.
- Items assessing A1.4.E may ask students to describe the relationship between functions in the form $y = mx+b$ or $y = a|x-h|+k$ to the parent functions $y = x$ and $y = |x|$.
- Items that require students to both write and solve an equation, inequality, or system w ill be assessed in A1.1.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.4.A *Write and* **solve linear equations and inequalities in one variable.**	**M1.3.A**		1,2	MC,CP	N
A1.4.B Write and graph an equation for a line given the slope and the y-intercept, the slope and a point on the line, or two points on the line, and translate between forms of linear equations.	**M1.3.D**		1	MC	N

Performance expectation A1.4 on next page.

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.4.C Identify and interpret the slope and intercepts of a linear function, including equations for parallel and perpendicular lines.	**M1.3.C**		1	MC	I
A1.4.D *Write and* **solve systems of two linear equations and inequalities in two variables.**	**M1.3.E**		1,2	MC,CP	N
A1.4.E Describe how changes in the parameters of linear functions and functions containing an absolute value of a linear expression affect their graphs and the relationships they represent.	**M1.3.B**		1,2	MC,SA	N

A1.5 Core Content: Quadratic functions and equations

(Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.5.D may expect students to give approximate solutions or numericall y exact solutions. When an item does not specify, students may do either.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.5.A Represent a quadratic function with a symbolic expression, as a graph, in a table, and with a description, and make connections among the representations.		**M2.2.A**	2	MC	I
A1.5.B *Sketch the graph of a quadratic function,* **describe the effects that changes in the parameters have on the graph, and interpret the x-intercepts as solutions to a quadratic equation**.		**M2.2.B**	1,2	MC	I
A1.5.C Solve quadratic equations that can be factored as (*ax* + *b*)(*cx* + *d*) where *a*, *b*, *c*, and *d* are integers.		**M2.2.D**	1,2	MC,CP	N
A1.5.D Solve quadratic equations that have real roots by completing the square and by using the quadratic formula.		**M2.2.F**	1,2	MC,CP	N

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A1.6 Core Content: Data and distributions

(Data/Statistics/Probability)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.6 may expect students to use statistical language to explain a comparison, inference, or conclusion.
- Items assessing A1.6.A may present data sets numerically or graphically.
- Items assessing A1.6.A may expect students to compute and/or evaluate the appropriat eness of different measures of center and variability to describe data sets.
- Items assessing A1.6.B may expect students to determine whether arguments based on data confuse association with causation.
- Items assessing A1.6.B may expect students to evaluate the reasonableness of and make judgments about statistical claims, reports, studies, and conclusions.
- Items assessing A1.6.D may expect students to make predictions involving interpolating and extrapolating from the original data set.
- Items assessing A1.6.D will ask students to draw a line that fits the data rather than a lin e of best fit.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.6.A Use and evaluate the accuracy of summary statistics to describe and compare data sets.	**M1.5.A**		2	MC,SA	Y
A1.6.B Make valid inferences and draw conclusions based on data.	**M1.5.C**		2,3	MC,SA	Y
A1.6.C Describe how linear transformations affect the center and spread of univariate data.	**M1.5.B**		2	MC	Y
A1.6.D Find the equation of a linear function that best fits bivariate data that are linearly related, interpret the slope and y-intercept of the line, and use the equation to make predictions.	**M1.3.F**		2	MC,SA	Y
A1.6.E Describe the correlation of data in scatterplots in terms of strong or weak and positive or negative.	**M1.3.G**		2	MC	I

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A1.7 Additional Key Content

(Algebra)

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Items assessing A1.7 will not ask students to write exponential functions or equations.
- Items assessing A1.7.A may ask students to make comparisons between exponential fun ctions.
- Items assessing A1.7.B may expect students to approximate solutions and, when possibl e, give answers that are numerically exact.
- Items assessing A1.7.B will include equations of the form $y = ab^x$ where b is greater th an 1.
- Items assessing A1.7.C that give a formula for a_n will clarify that a_1 is the first term in the sequence.
- Recursive and explicit forms will be represented using subscript notation, i.e., $t_n = t_{n-1} + 9$ or $a_n = 3(n-2) + 5$.
- Items assessing A1.7.D will include a maximum of four variables in an equation.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.7.A *Sketch the graph* **for an exponential function of the form $y = ab^n$ where *n* is an integer, describe the effects that changes in the parameters *a* and *b* have on the graph, and answer questions that arise in situations modeled by exponential functions.**	**M1.7.A**		1,2	MC,SA	I
A1.7.B Find and approximate solutions to exponential equations.	**M1.7.B**		2	MC	N
A1.7.C Express arithmetic and geometric sequences in both explicit and recursive forms, translate between the two forms, explain how rate of change is represented in each form, and use the forms to find specific terms in the sequence.	**M1.7.D**		1,2	MC,CP	N
A1.7.D Solve an equation involving several variables by expressing one variable in terms of the others.	**M1.6.D**		1,2	MC	N

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A1.8 Core Processes: Reasoning, problem solving, and communication

Stimulus, Stem, and Prompt Rules

- Use Item Development Guidelines at the beginning of this document.
- Problem solving items will include A1.8.A, A1.8.B, A1.8.C.
- Items assessing A1.8.A-C may include figures that are not drawn to scale and include a statement "Picture is **not** drawn to scale."
- Items assessing A1.8.G may ask a student to support or contradict a given conclusion.
- Mathematics content for process items must be from performance expectations that are common to Algebra 1 and Mathematics 1.

Content Expectations

Items may ask students to:	*Integrated Sequence*		*C.C.*	*Format*	*Ctxt*
A1.8.A Analyze a problem situation and represent it mathematically.	**M1.8. A-C**		3	MC,SA	Y
A1.8.B Select and apply strategies to solve problems.					
A1.8.C Evaluate a solution for reasonableness, verify its accuracy, and interpret the solution in the context of the original problem.					
A1.8.D *Generalize a solution strategy for a single problem to a class of related problems, and apply a strategy for a class of related problems to solve specific problems.*	M1.8.D		(*3,4*)	NA	NA
A1.8.E Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.	**M1.8.E**		2,3	SA	Y
A1.8.F *Summarize mathematical ideas with precision and efficiency for a given audience and purpose.*	M1.8.F		(*2,3*)	NA	NA
A1.8.G Synthesize information to draw conclusions, and evaluate the arguments and conclusions of others.	**M1.8.G**		3	MC,SA	Y
A1.8.H *Use inductive reasoning about algebra and the properties of numbers to make conjectures, and use deductive reasoning to prove or disprove conjectures.*	M1.8.H		(*4*)	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
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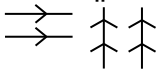
Ctxt=Contextual Situation ***I***= Item dependent ***Y***= Yes Context ***N***= No Context

Mathematics Symbols First Used in Exam Items

Strand	Name	Symbol	Grade
Operations	addition	+	3
	subtraction	-	3
	multiplication	×	3
		( )	5
		•	6
	division	÷	3
		– (for ex. $\frac{6}{3}$)	4
	absolute value of *a*	$\|a\|$	7
	exponents	base exponent (for ex. 3^2)	8
	square root of *a*	$\sqrt{a}$	8
Algebra	equal to	=	3
	less than	<	3
	greater than	>	3
	less than or equal to	≤	8
	greater than or equal to	≥	8
	not equal to	≠	8
	function	f(*x*)	EOC
	brackets	[ ]	EOC
Geometric Sense	right angle	(in diagram)	3
	pi	π	6
	congruent	 (in diagram)	7
	line segment AB	$\overline{AB}$	7
	angle A	$\angle A, \angle BAC$	8
	triangle ABC	$\Delta\, ABC$	8
	perpendicular	⊥ (in text)	8
	parallel	∥ (in text)	8
		 (in diagram)	EOC
	similar	~	EOC
	measure of angle A	$m \angle A$	EOC
	congruent	≅	EOC
	ray AB	$\overrightarrow{AB}$	EOC
	line AB	$\overleftrightarrow{AB}$	EOC
	arc AB	$\overset{\frown}{AB}$	EOC

Mathematics Formula Sheets for End-of-Course Exams

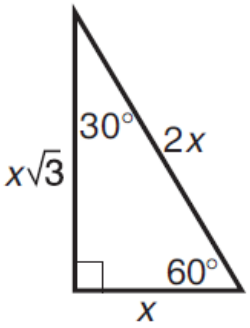
Use at least two decimal place values when approximating square roots or trigonometric ratios.

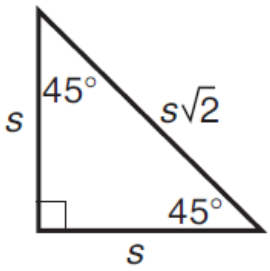
Description	Formula	Variables
Arc Length	$L = \frac{m\overset{\frown}{BC}}{360^\circ}\pi d$	*L*: Arc Length *B, C*: endpoints of arc *d*: diameter of the circle *m*: the measure of
Area of Sector	$A = \frac{m\overset{\frown}{BC}}{360^\circ}\pi r^2$	*A*: Area of Sector *B, C*: endpoints of intercepted arc *r*: radius of the circle *m*: the measure of
Cylinder	$SA = 2\pi r^2 + 2\pi rh$	*SA*: Surface Area *r*: radius of the base *h*: height
	$V = \pi r^2 h$	*V*: Volume *r*: radius of the base *h*: height
Cone	$SA = \pi r^2 + \pi rl$	*SA*: Surface Area *r*: radius of the base *l*: slant height
	$V = \frac{1}{3}Bh$ **or** $V = \frac{1}{3}\pi r^2 h$	*V*: Volume *r*: radius of the base *h*: height *B*: area of the base
Prism	$V = Bh$	*V*: Volume *B*: area of the base *H*: height
	$SA = 2B + Ph$ **or** $SA = 2B + L$	*SA*: Surface Area *B*: area of the base *P*: Perimeter of the base *h*: height *L*: lateral surface area
Pyramid	$V = \frac{1}{3}Bh$	*V*: Volume *B*: area of the base *h*: height
Quadratic Formula	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	*x*: solution a, b, c: coefficients
Sphere	$V = \frac{4}{3}\pi r^3$	*V*: Volume *r*: radius
	$SA = 4\pi r^2$	*SA*: Surface Area *r*: radius

Mathematics Formula Sheets for End-of-Course Exams

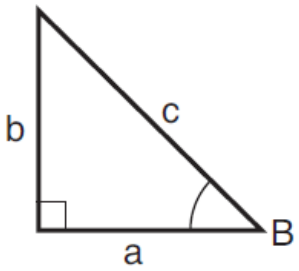
Use at least two decimal place values when approximating square roots or trigonometric ratios.

Special Right Triangles





Trigonometric Ratios

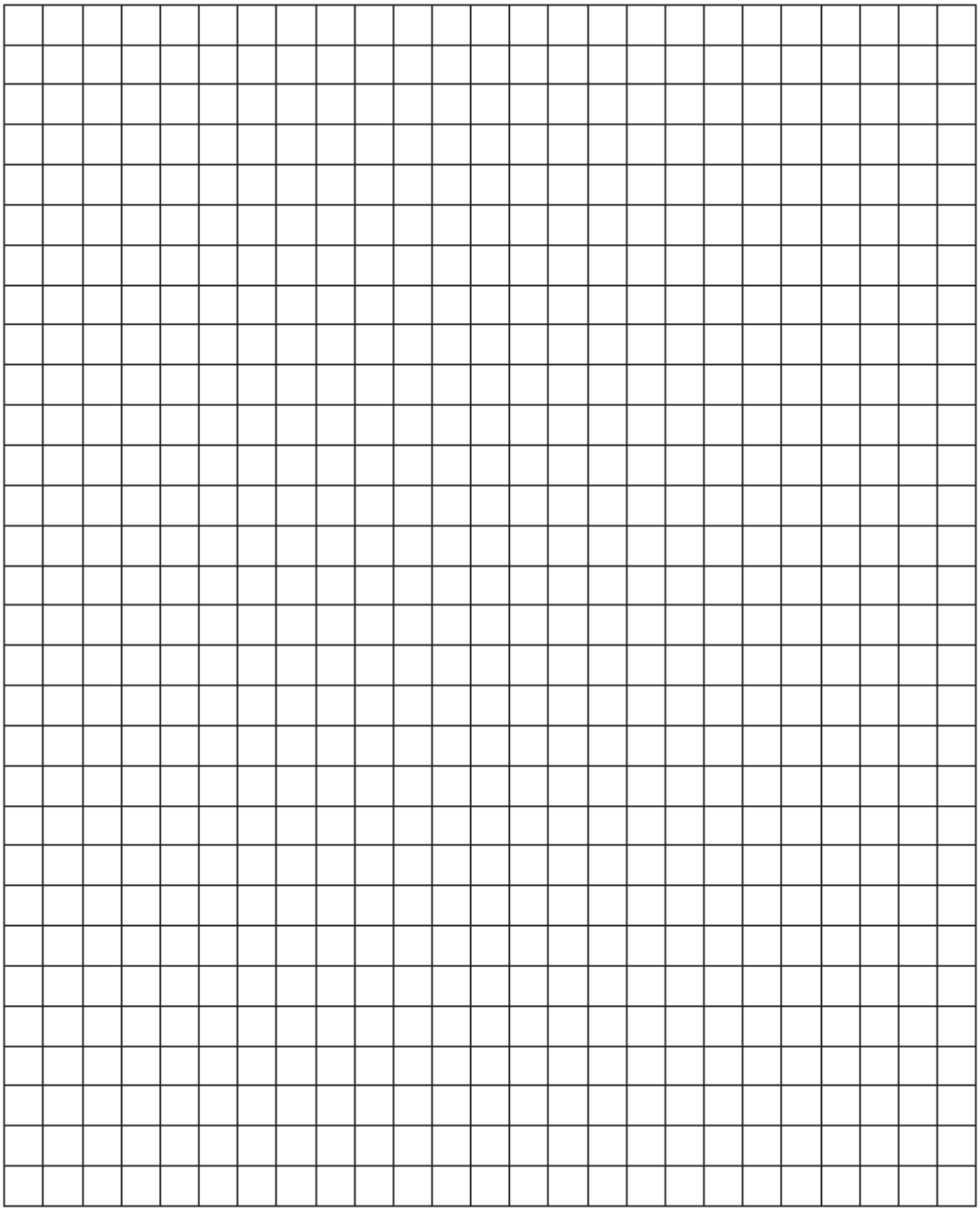


$$\sin B = \frac{b}{c}$$

$$\cos B = \frac{a}{c}$$

$$\tan B = \frac{b}{a}$$

Mathematics End-of-Course Graph Paper



Measurement Vocabulary

Attributes, Units, Abbreviations, and Grade Level First-Used in Assessment Items

The levels in parentheses refer to the grades at which students should develop an oral understanding of the terms according to the K-2 Standards.

Attribute	Unit	Grade
Length (K)	inch (in.)	3 (2)
	foot (ft)	3 (2)
	yard (yd)	3 (2)
	mile (mi)	4
	millimeter (mm)	4
	centimeter (cm)	3 (2)
	meter (m)	3 (2)
	kilometer (km)	4
Capacity (K)	cup (c)	3
	pint (pt)	3
	quart (qt)	3
	gallon (gal)	3
	milliliter (mL)	3
	liter (L)	3
	kiloliter (kL)	4
Weight (K)	ounce (oz)	3
	pound (lb)	3
	ton (t)	7
Mass	gram (g)	3
	kilogram (kg)	4

Attribute	Unit	Grade
Time	second (s)	4
	minute (min)	4 (2)
	hour (h)	4 (2)
	day (d)	4 (2)
	week (wk)	4 (2)
	month (mo)	4 (2)
	year (y)	4 (2)
Temperature	Degree Fahrenheit (^oF)	3
	Degree Celsius (^oC)	3
Angle	Degrees (^{o})	5

Conversions

- In grades 4-6, students are expected to convert within a measurement system but not between measurement systems. For example, 3 feet = 1 yard is a conversion within the U.S. customary system, but 1 yard ≈ 0.91 meter is a conversion between U.S. Customary and metric systems.
- In grade 7 and Geometry/Integrated Mathematics 2 EOCs students may be asked to convert between systems and a conversion factor will be provided.
- Most dictionaries list conversion factors.