South Carolina Academic Standards for Mathematics
2007 High School Support Document

High School Core Area
Elementary Algebra

South Carolina Department of Education
Office of Academic Standards

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Introduction

The High School Mathematics Standards writing team developed the High School Mathematics Standards Support Guide in cooperation with South Carolina educators. The High School Mathematics Standards Support Guide expands upon each indicator to provide educators with additional content information such as guidelines for assessment. The High School Mathematics Standards support guide will assist educators with the successful implementation of standards-based mathematics instruction. Please note that this document is an unedited draft.

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Elementary Algebra Overview from the 2007 South Carolina Academic Standards for Mathematics

The academic standards for the elementary algebra core area establish the process skills and core content for Algebra 1, Mathematics for the Technologies 1, and Mathematics for the Technologies 2, which should provide students with the mathematics skills and conceptual understanding necessary for them to further their mathematical education or to pursue mathematics-related technical careers. These standards will be the basis for the development of the items on the state-required end-of-course examination for Algebra 1 and Mathematics for the Technologies 2.

The content of the elementary algebra standards encompasses the real number system; operations involving exponents, matrices, and algebraic expressions; relations and functions; writing and solving linear equations; graphs and characteristics of linear equations; and quadratic relationships and functions. Teachers, schools, and districts should use the elementary algebra standards to make decisions concerning the structure and content of Algebra 1, Mathematics for the Technologies 1, and Mathematics for the Technologies 2. Content in these three courses may go beyond the elementary algebra standards.

All courses based on the academic standards for elementary algebra must include instruction using the mathematics process standards, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Educators must determine the extent to which such courses or individual classes may go beyond these standards. Such decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the objectives of the particular courses or individual classes.

In all courses based on the elementary algebra standards, hand-held graphing calculators are required for instruction and assessment. Students should learn to use a variety of ways to represent data, to use a variety of mathematical tools such as graph paper, and to use technologies such as graphing calculators to solve problems.

Note: The term *including* appears in parenthetical statements in the high school mathematics indicators to introduce a list of specifics that are intended to clarify and focus the teaching and learning of the particular concept. That is, within these parenthetical including statements are specified the components of the indicator that are critical for the particular core area with regard both to the state assessments and to the management of time in the classroom. While instruction must focus on the entire indicator, educators must be certain to cover the components specified in the parenthetical *including* statements.

2007 Mathematics Academic Standards Support Guide for the High School Core Area of Elementary Algebra

This section of the standards support guide addresses Elementary Algebra Standard EA-2 and provides additional information about its indicators EA-2.1 thorough EA-2.10.

Standard EA-2: The student will demonstrate through the mathematical processes an understanding of the real number system and operations involving exponents, matrices, and algebraic expressions.

Indicators

EA-2.1 Exemplify elements of the real number system (including integers, rational numbers, and irrational numbers).
EA-2.2 Apply the laws of exponents and roots to solve problems.
EA-2.3 Carry out a procedure to perform operations (including multiplication and division) with numbers written in scientific notation.
EA-2.4 Use dimensional analysis to convert units of measure within a system.
EA-2.5 Carry out a procedure using the properties of real numbers (including commutative, associative, and distributive) to simplify expressions.
EA-2.6 Carry out a procedure to evaluate an expression by substituting a value for the variable.
EA-2.7 Carry out a procedure (including addition, subtraction, multiplication, and division by a monomial) to simplify polynomial expressions.
EA-2.8 Carry out a procedure to factor binomials, trinomials, and polynomials by using various techniques (including the greatest common factor, the difference between two squares, and quadratic trinomials).
EA-2.9 Carry out a procedure to perform operations with matrices (including addition, subtraction, and scalar multiplication).
EA-2.10 Represent applied problems by using matrices.

EA-2.1 Exemplify elements of the real number system (including integers, rational numbers, and irrational numbers).

Taxonomy Level
2.2-B
Cognitive Process Dimension: Understand
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Real Numbers
Integers
Rational Numbers
Irrational Numbers

Continuum of Knowledge
In 8th grade students compare rational and irrational numbers by using the symbols ≤, ≥, <, >, and = (8-2.4). Also, students apply an algorithm to add, subtract, multiply, and divide integers (8-2.1).

In Elementary Algebra students find examples of the following subsets of the real numbers: integers, rational numbers, and irrational numbers.

In Intermediate Algebra, students build on their knowledge of the real number system by studying complex numbers. Intermediate Algebra students carry out a procedure to simplify expressions involving powers of *i* (IA-3.1). In addition, Intermediate Algebra students carry out a procedure to perform operations with complex numbers (including addition, subtraction, multiplication, and division) (IA-3.2).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Give examples of integers, rational numbers, and irrational numbers.

Understand how integers, rational numbers, and irrational numbers are interrelated.

Classify numbers as integers, rational numbers, or irrational numbers.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Identifying 5 is an integer and a rational number.

Provide an example of a number that is an integer and a rational number, such as -7.

Identify $0.\overline{66}$ as a rational number.

Give an example of a rational number such as - ⅜.

Identify 0.25 as a rational number.

Provide an example of an irrational number, such as 0.676676667... (does not repeat in a pattern or terminate) or ∏.

Identify $\sqrt{2}$ as an irrational number.

Explain why $\sqrt{7}$ is irrational (formal proof not required).

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Know additional subsets of the real number system (whole numbers and counting numbers).

Study imaginary numbers.

Study complex numbers.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Identify 7 as a counting number.

Know that infinitely many irrational numbers are between 0 and 1 on the number line.

Give an example of a complex number, such as 5 + 3i.

Misconceptions/Common Errors
Students may not identify integers as a subset of the rational numbers. Therefore, students may fail to classify integers as rational numbers.

Technology Note
Students may use technology to identify the existence of a pattern when calculating a quotient.

Assessment Guidelines
The objective of this indicator is to exemplify elements of the real number system. Therefore, the primary focus of the assessment should be for students to give examples of integers, rational numbers, and irrational numbers. Because this is conceptual knowledge, assessments should test the student's ability to apply this concept to any integer, rational number, or irrational number, not to be restricted to memorized examples. Students should understand the interrelationships among integers, rational numbers, and irrational numbers.
In addition to exemplify, students should be able to:
Classify numbers as integers, rational numbers, or irrational numbers.

EA-2.2 Apply the laws of exponents and roots (radicals) to solve problems.

Taxonomy Level
3-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Exponents
Powers
Base
Reciprocal
Radical
Radicand
Index
Root
Square root

Continuum of Knowledge
In 6th grade students represent whole numbers in exponential form (6-2.9). In 7th grade students translate between standard for and exponential form (7-2.6), represent the location of rational numbers and square roots of perfect squares on a number line (7-2.2), compare rational numbers, percentages, and square roots of perfect squares by using the symbols ≤, ≥, <, >, and =, and Understand the inverse relationship between squaring and finding the square roots of perfect squares. In 8th grade students apply strategies and procedures to approximate between two whole numbers the square roots or cube roots of numbers less than 1,000.

In Elementary Algebra students apply the laws of powers (exponents) and roots (radicals) to solve problems.

Intermediate Algebra students carry out a procedure to perform operations (including multiplication, exponentiation, and division) with polynomial expressions (IA-4.1). Carry out a procedure to simplify algebraic expressions involving rational exponents (IA-4.5). Carry out a procedure to simplify algebraic expressions involving logarithms (IA-4.6). Carry out a procedure to perform operations with expressions involving rational exponents (including addition, subtraction, multiplication, division, and exponentiation) (IA-4.7). Carry out a procedure to solve radical equations algebraically (IA-4.9). Carry out a procedure to graph exponential functions (IA-4.14).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Evaluate expressions and simplify expressions using the following properties. The values of *a* and *b* are integral.

Product of powers with like bases ($x^a x^b = x^{a+b}$).

Power of a power ($\left(x^a\right)^b = x^{ab}$).

Power of a product ($(xy)^a = x^a y^a$).

Zero power of a nonzero number is 1 ($x^0 = 1, \text{if } x \neq 0$).

Reciprocal ($x^{-a} = \frac{1}{x^a}, \text{if } x \neq 0$).

Quotient of powers with like bases ($\frac{x^a}{x^b} = x^{a-b}, \text{if } x \neq 0$).

Powers of quotient ($\left(\frac{x}{y}\right)^a = \frac{x^a}{y^a}, \text{if } y \neq 0$).

The principle square root is positive.

$\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$ for a, b > 0.

$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$ for a, b > 0.

Examples of Essential Tasks

These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Simplify $x^3 \cdot x^5$.

Simplify $y^6 \cdot y^{-10}$

Simplify (- 5 rm)^2 ($\frac{1}{2}$ r^{3}m^4)^2.

Simplify (7a)$^{-3}$.

Evaluate (4^{-1})$^{-2}$

Evaluate 9^0.

Evaluate $\left(\frac{2}{5}\right)^{-2}$.

Simplify $\frac{-2x^{-1}}{8x^2y^{-3}}$.

Simplify $\left(\frac{zy^3}{-5z^2y^{-3}}\right)^3$.

Sq root of (-3)^2 = 3

Sq. rt. 2 x sq. rt 3 = Sq. rt 6

Sq. rt. 2 x sq. rt 8 = 4

simplify sq root of 90 = 3 x sq root 10

simplify sq root of (81/49)

simplify sq root 27/sq root 3

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Problems involving rational exponents

$\sqrt{a^2} = |a|$. This is non-essential knowledge for this indicator because the expectation is for students to simplify problems where the radicand will be numerical rather than a variable expression.

Rationalizing a denominator

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Evaluate (include a rational exponent problem)

Simplify 1/sq. root 2

Sq root of x^7, Sq. root of x^2, etc.

Misconceptions/Common Error
Sometimes students have difficulty determining the value of the expression x^0 ($x \neq 0$). By using the division rule $\frac{x^4}{x^4} = x^{4-4} = x^0$. If $x \neq 0$, then $\frac{x^4}{x^4} = 1$. Therefore, $x^0 = 1$, if $x \neq 0$.

If we go with the above radical laws, then note the following:
Radicals with the same index can be multiplied and divided. However, radicals can not be directly added. That is, $\sqrt{9} + \sqrt{16} \neq \sqrt{25}$. In general, $\sqrt[n]{a} + \sqrt[n]{b} \neq \sqrt[n]{a+b}$.

Technology Note
Students may use technology to verify solutions.

Assessment Guidelines
The objective of this indicator is to carry out or use the laws of powers (exponents) and roots (radicals) to evaluate and to simplify expressions. Therefore, the primary focus of the assessment should be for students to carry out or use such procedures in given situations.

EA-2.3 Carry out a procedure to perform operations (including multiplication and division) with numbers written in scientific notation.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Standard notation
Scientific notation
Coefficient
Base
Power

Continuum of Knowledge
In 7th grade students translate between standard form and scientific notation (7-2.7).

In Elementary Algebra, students carry out a procedure to perform the operations of multiplication and division with numbers written in scientific notation. Student understanding should exceed rote operational proficiency.

This skill is necessary in the subsequent study of mathematics and other disciplines such as science and technology.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Carry out a procedure to multiply numbers written in scientific notation.
$(N \times 10^x)(M \times 10^y) = (N)(M) \times 10^{x+y}$

Carry out a procedure to divide numbers written in scientific notation.
$$\frac{N\,x10^{x}}{M\,x10^{y}} = \frac{N}{M}\,x10^{x-y}$$

Be able to compute with integers.

Express the final product or quotient in scientific notation.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

$(5.0 \times 10^3)(2.0 \times 10^6)$

First, $5.0 \times 2.0 = 10.0$
Second, $10^3 \times 10^6 = 10^{3+6} = 10^9$
Finally, 10.0×10^9

$(2.3 \times 10^4)(6.1 \times 10^{-8})$

First, $2.3 \times 6.1 = 14.03$
Second, $10^4 \times 10^{-8} = 10^{4+(-8)} = 10^{-4}$
Then, 14.03×10^{-4} (answer is not in scientific notation)
Finally, 1.403×10^{-3} (answer is in scientific notation)

$$\frac{(6.3 \times 10^7)}{(2.1 \times 10^4)}$$

First, $\frac{6.3}{2.1} = 3$

Second, $\frac{10^7}{10^4} = 10^{7-4} = 10^3$

Finally, 3.0×10^3

$$\frac{(8.0 \times 10^4)}{(2.0 \times 10^{-2})}$$

First, $\frac{8.0}{2.0} = 4$

Second, $\frac{10^4}{10^{-2}} = 10^{4-(-2)} = 10^{4+2} = 10^6$

Finally, 4.0×10^6

$$\frac{(8.58 \times 10^{11})}{(3.3 \times 10^{18})}$$

First, $\frac{8.58}{3.3} = 2.6$

Second, $\frac{10^{11}}{10^{18}} = 10^{11-18} = 10^{-7}$
Finally, 2.6×10^{-7}

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

To carry out procedures to add, subtract, or exponentiate numbers expressed in scientific notation.

To know how to express exponents using other notations, such as 345,000,000 written as 3.45E +8 or as 3.45 X 10^8.

To translate between standard form and scientific notation. The numbers will be given in scientific notation.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

$4.5 \times 10^{11} + 3.29 \times 10^{9}$

Express 345,000,000 as 3.45E +8 or as 3.45 X 10^8.

$(3{,}540{,}000{,}000)\ (7.22 \times 10^{6})$

Misconceptions/Common Errors
Students may misapply the laws of exponents and/or misapply the rules for performing operations with integers.

Technology Note
Students may use technology to verify solutions. When using technology to verify solutions, students need to be familiar with the scientific notation used for the calculator. Students should be aware of the limitations of some calculators to perform multiplication or division of numbers written in scientific notation. Sometimes the answer will "overflow" the calculator. For example 3.1×10^{75} times 2.6×10^{35} will produce an error message on some scientific calculators and graphing calculators. In such a case, students could not use the technology to verify solutions. For example, when using the TI-84 plus Silver edition graphing calculator when the answer has an exponent that is greater than 99, then the answer will "overflow" the calculator producing and error message.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to perform the operations of multiplication and division with numbers written in scientific notation. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.4 Use dimensional analysis to convert units of measure within a system.

Taxonomy Level
3.2-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Units of measure
Conversion factor
Dimensional analysis

Continuum of Knowledge

In 7th grade students Use one-step unit analysis to convert between and within the U.S. Customary System and the metric system (7-5.5). In 8th grade students use multistep unit analysis to convert between and within U.S. Customary System and the metric system (8-5.7).

In Elementary Algebra students use dimensional analysis to convert units of measure within a system. Student understanding should exceed rote operational proficiency.

This essential skill is necessary in all subsequent study of mathematics.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Set up a unit conversion problem using dimensional analysis.

Perform calculations to convert units.

Determine if an expression correctly converts units of measure within a system.

Perform dimensional analysis with problems involving compound units such as mi/hr.

Students should be able to recall the following list of conversion factors to solve dimensional analysis problems. Any other conversion factors that are required to solve the problem will be provided.

U.S. Customary System
60 seconds = 1 minute
60 minutes = 1 hour
24 hours = 1 day

7 days = 1 week
12 months = 1 year
365 days = 1 year
52 weeks = 1 year

12 inches = 1 foot
3 feet = 1 yard
5,280 feet = 1 mile

8 liquid ounces = 1 cup
2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

16 ounces = 1 pound

Metric System
1000 millimeters = 1 meter.
100 centimeters = 1 meter
1000 meters = 1 kilometer

1000 milliliters = 1 liter
100 centiliters = 1 liter
1000 liters = 1 kiloliter

1000 milligrams = 1 gram
100 centigrams = 1 gram
1000 grams = 1 kilogram

Note about Metric System: Students should understand the organizational structure of the metric system, including the meaning of prefixes, to facilitate recollection of these conversion factors.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

> The mass of an object is 3.5 kg. What is the mass of the object in grams (g)?
> $3.5 kg \, x \frac{1000 \, g}{1 kg} = 3{,}500 \, g$
>
> A road is 2640 yards long. How long is the road in miles?
> $2640 \, yd \, x \frac{3 \, ft}{1 \, yd} \, x \frac{1 mi}{5280 \, ft} = 1.5 mi$

How many pints are there in 2.75 gallons of tomato soup?

$$2.75\,gallons\ x\frac{4\,quarts}{1\,gallon}x\frac{2\,p\text{int}\,s}{1\,quart}=22\ \ p\text{int}\,s$$

How many liters of gasoline are in 500 ml?

$$500\,ml\,x\frac{1l}{1000\,ml}=0.5l$$

A bedroom has 11,664 square inches of floor space. How many square feet of floor space does the bedroom have?

$$\left(11{,}664\,sq\,in\,x\frac{1sq\ ft}{144\,sq\,in}=81sq\ ft\right)$$

A bedroom has 11,664 square inches of floor space. How many square yards of floor space does the bedroom have?

$$\left(11{,}664\,sq\,in\,x\frac{1sq\ ft}{144\,sq\,in}x\frac{1sq\,yd}{9\,sq\ ft}=9\,sq\,yd\right)$$

One aspirin tablet contains 375 mg of active ingredients. How many grams (g) of active ingredient are in one tablet?

$$(375\,mg\,x\frac{1g}{1000\,mg}=0.375\,g\,)$$

The escape velocity from earth's surface is approximately 7.0 mi/sec. What is the escape velocity in mi/hr?

$$(\frac{7.0\,mi}{1\text{sec}}x\frac{3600\text{sec}}{1hr}=25{,}200\frac{mi}{hr}\,)$$

or

$$(\frac{7.0\,mi}{1\text{sec}}x\frac{60\text{sec}}{1\text{min}}x\frac{60\text{min}}{1hr}=25{,}200\frac{mi}{hr}\,)$$

A car is traveling at 70 miles per hour on an interstate highway. a. How many feet per second is the car traveling? b. If a football field is 300 feet long, how many football field lengths does the car travel in one second?

a. $$\frac{70\,mi}{1hr}x\frac{5280\ ft}{1mi}x\frac{1hr}{3600\text{sec}}=102.\bar{6}\ \frac{ft}{\text{sec}}$$

b. $$\frac{102.\bar{6}\ ft}{1\text{sec}}x\frac{1\ football\ \ field\ length}{300\ ft}=0.34\bar{2}\frac{football\ \ field\ lengths}{\text{sec}}$$

Which of the following dimensional analysis expressions converts 25 $\frac{mi}{hr}$ to $\frac{ft}{\sec}$?

a. $25\frac{mi}{hr} x \frac{1mi}{5280\ ft} x \frac{1\ hr}{60\min} x \frac{1\min}{60\sec}$

b. $25\frac{mi}{hr} x \frac{5280\ ft}{1mi} x \frac{60\min}{1hr} x \frac{60\sec}{1\min}$

c. $25\frac{mi}{hr} x \frac{5280\ ft}{1mi} x \frac{1hr}{60\min} x \frac{1\min}{60\sec}$

d. $25\frac{mi}{hr} x \frac{1\ mi}{5280\ ft} x \frac{60\min}{1hr} x \frac{60\sec}{1\min}$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Memorize conversion factors beyond the list provided above.

Convert between the U.S. Customary System and the metric system.

Convert units of measure that require more than three conversion factors.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

How many milliliters are in a gallon of gasoline?

How many ounces are in 10 grams?

If a car is traveling 55 miles per hour how many meters per second is the car traveling?

Misconceptions/Common Errors
Students may fail to recognize that as the size of the unit changes the number of units change accordingly. For example, when converting from a larger unit to a smaller unit of measure, the number of units increases. When converting from a smaller unit to a larger unit of measure, the number of units decreases.

Students may not realize that when a conversion factor is written as a fraction, the numerator and the denominator are equal; therefore, the fraction equals 1. Multiplying by the conversion factor, an unusual appearing 1, does not change the value but expresses the quantity in different units.

For example, in the conversion problem $5\,yards\,x\,\frac{3\,feet}{1\,yard}=15\,feet$, the conversion factor $\frac{3\,feet}{1\,yard}=\frac{1yard}{3\,feet}=1$. Therefore, multiplying by 1 does not change the value, because the length is 5 yards = 15 feet. However, the size of the unit changes therefore the number of units change.

Technology Note
Students may use technology to perform the operations of multiplication and division when evaluating expressions that are usually beyond the scope of mental calculation.

Assessment Guidelines
The objective of this indicator is to use dimensional analysis to convert units of measure within a system. Therefore, the primary focus of the assessment should be for students to apply such procedures to unfamiliar unit conversions within a given measurement system. To successfully use dimensional analysis to convert units, students' understanding must exceed rote operational proficiency. Students should understand the concept of dimensional analysis.

EA-2.5 Carry out a procedure using the properties of real numbers (including commutative, associative, and distributive) to simplify expressions.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Properties of real numbers
Commutative Property
Associative Property
Distributive Property
Expressions
Terms

Continuum of Knowledge

In 8th grade students use commutative, associative, and distributive properties to examine the equivalence of a variety of algebraic expressions (8-3.3).

In Elementary Algebra students carry out a procedure using the properties of real numbers (including commutative, associative, and distributive) to simplify expressions.

This essential skill is necessary in all subsequent study of mathematics.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use one or more of the following properties of the real number system to simplify expressions: Commutative, Associate, and Distributive.

Simply algebraic expressions, including numerical expression.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Which expression is equivalent to 5(3x-2y)?
- 15x-2y
- 3x-10y
- 15x-10y
- 5xy

-30xy

Simplify -5 + (3m – 2)m

Simplify 4(2 + x) + (1 – 3x) + 7

Simplify $2\pi+5\pi$

Solution: $2\pi+5\pi=(2+5)\pi=7\pi$

Simplify $\sqrt{2}+3\sqrt{2}=(1+3)\sqrt{2}=4\sqrt{2}$

Solution: $\sqrt{2}+3\sqrt{2}=(1+3)\sqrt{2}=4\sqrt{2}$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Identify which property is used to justify equivalent expressions.

Demonstrate knowledge of additional properties of the real number system beyond the Associative, Commutative, and Distributive Property.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

a(x + y) = ax + ay is true by what property?

(m + n) + p = m + (n + p) according to what property?

7 = 7 according to what property?

Misconceptions/Common Errors
Students may not properly apply the distributing property stating that 3(x + 2) = 3x + 2 instead of the correct answer, which is
3(x +2) = 3x + 6.

Technology Note
Students may use technology to verify equivalent expressions by substituting values and/or using computer algebra systems (CASs).

Assessment Guidelines
The objective of this indicator is to carry out a procedure using the properties of real numbers (including commutative, associative, and distributive) to simplify expressions. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.6 Carry out a procedure to evaluate an expression by substituting a value for the variable.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Evaluation
Simplification
Substitution

Continuum of Knowledge
In 6th grade students apply order of operations to simplify whole-number expressions (6-3.2). Students write variable expressions to represent quantities (6-3.3).

In Elementary Algebra, students use substitution to find a numerical value for an expression. Student understanding should exceed rote operational proficiency.

This essential skill is necessary in all subsequent study of mathematics.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Understand how variables are used to represent numerical quantities.

Substitute values for one or more variables.

Evaluate algebraic expressions for specified real numerical values.

Evaluate algebraic expressions that may involve square roots and/or exponents.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Evaluate $x + y$ for $x = 0.3$, $y = 2/5$

Evaluate x^2 for $x = \sqrt{3}$

Evaluate $\frac{xy^2z^3}{y}$ for $x = 5$, $y = 3$, and $z = -2$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Substitute and evaluate expressions that are not related to the indicators of Elementary Algebra.

Substitute and evaluate expressions involving imaginary numbers.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Evaluate Sin x for x = ∏/2

Evaluate log x for x = 100

Misconceptions/Common Errors
Students may not recognize xy, (x)(y), and x•y, as x multiplied by y.

Students may misapply the Order of Operations.

Technology Note
Students may use technology for complex computation.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to evaluate an expression by substituting values for variables. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.7 Carry out a procedure (including addition, subtraction, multiplication, and division by a monomial) to simplify polynomial expressions.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Expressions
Terms
Monomial
Polynomial

Continuum of Knowledge
In 8th grade students apply order of operations to simplify whole-number expressions (6-3.2). Apply an algorithm to add, subtract, multiply, and divide integers (8-2.1). Understand equivalent symbolic expressions as distinct symbolic forms that represent the same relationship (6-1.4, 7-1.4, and 8-1.4). Use commutative, associative, and distributive properties to examine the equivalence of a variety of algebraic expressions (8-3.3).

In Elementary Algebra students carry out a procedure (including addition, subtraction, multiplication, and division by a monomial) to simplify polynomial expressions.

In Intermediate Algebra, students build on their knowledge of the real number system by studying complex numbers. Intermediate Algebra students carry out a procedure to perform operations (including multiplication, exponentiation, and division) with polynomial expressions (IA-4.1). Also, students carry out procedures to perform operations on polynomial functions (including $f(x) + g(x)$, $f(x) - g(x)$, $f(x) \bullet g(x)$, and $f(x)/g(x)$) (IA-2.5).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Add, subtract, and/or multiply polynomial expressions.

Divide a polynomial by a monomial.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

$(x + 5) + (2x + 3)$

$(2x^3 + 5x^2 – 3) + (-4x^3 + 9x^2 – 1)$

$(3x^4 – 8x^3 + 2x^2 – 3) + (6x^3 – 2x^2 + 5)$

$(x + 5) – (2x + 3)$

$(2x^3 + 5x^2 – 3) – (-4x^3 + 9x^2 – 1)$

$(3x^4 – 8x^3 + 2x^2 – 3) – (6x^3 – 2x^2 + 5)$

$y (y + 8)$

$(x + 3) (x + 3)$

$(x + 5) (x – 5)$

$(2x^2 – 3) (x – 7)$

$(x – 1) (-4x^2 + x + 12)$

$$\frac{-10x+5}{5}$$

$$\frac{9x^3+3x-6}{3x}$$

$$\frac{6x^4-9x^3+3x^2}{3x^2}$$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Multiply polynomial expressions that exceed the number of terms in a binomial times a trinomial.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

$(5x^2 - x + 3) (-7x^2 + 8x + 12)$

Misconceptions/Common Errors

When subtracting two polynomials students may forget to distribute the negative thus subtracting only the first term of the subtrahend rather than the entire polynomial provided that the polynomial has more than one term. (minuend – subtrahend = difference)

Technology Note
Students may use computer algebra system technology, which is capable of performing symbolic manipulations, to verify solutions.

Assessment Guidelines
The objective of this indicator is to carry out a procedure (including addition, subtraction, multiplication, and division by a monomial) to simplify polynomial expressions. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.8 Carry out a procedure to factor binomials, trinomials, and polynomials by using various techniques (including the greatest common factor, the difference between two squares, and quadratic trinomials).

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Factor
Greatest Common Factor
Binomial
Trinomial
Polynomial

Continuum of Knowledge
In 5^{th} grade students generate strategies to find the greatest common factor and the least common multiple of two whole numbers (5-2.7). Also, in 6^{th} grade students represent the prime factorization of numbers by using exponents (6-2.8).

In Elementary Algebra students carry out a procedure to factor binomials, trinomials, and polynomials by using various techniques (including the greatest common factor, the difference between two squares, and quadratic trinomials).

In Intermediate Algebra, students carry out a procedure to solve quadratic equations algebraically (including factoring, completing the square, and applying the quadratic formula) (IA-3.3). In addition, students carry out a procedure to solve polynomial equations (including factoring by grouping, factoring the difference between two squares, factoring the sum of two cubes, and factoring the difference between two cubes) (IA-4.3).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Remove the greatest common factor (GCF).

Apply the difference of two squares formula: $x^2-y^2 = (x+y)(x-y)$.

Factor quadratic trinomials by using a trial-and-error method or another suitable method.

Recognize a polynomial as being prime.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Factor:

$14x^3+4$

$-3x^2-3$

$6x-6y$

X^2-25

$5x^2-75$

$81c^2-49d^2$

$X^2+8x+15$

y^2-2y+1

$3x^2-9x+6$

$x^2-6x-27$

$n^2+5n-36$

x^2+2x+5 (Students should recognize as prime.)

$7x^2+7x+7$ (GCF only and will not factor any more)

$3x^2y-21xy+3xy^2$ (GCF only and will not factor any more)

$5x^3-10x^2+5x-50$ (GCF only and will not factor any more)

$2x^2y+4xy-30y$ $[2y(x^2+2x-15) = 2y(x+5)(x-3)]$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Factor difference of two squares with more that one variable in a term

Factor by grouping

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Factor
$81x^2c^2-49d^2$

x^4+2x^3-x-2
Solution by factor by grouping: $x^3(x+2)-1(x+2) = (x+2)(x^3-1)$

Misconceptions/Common Errors

Students fail to first remove greatest common factors, provided one exists.

When factoring quadratic trinomials, students sometime write factors that are not correct for the middle term. Therefore, students may wish to use multiplication to check the factored form, giving special attention to the middle term.

Students may not recognize that x^2+y^2 is prime.

Technology Note
Students may use computer algebra system technology, which is capable of performing symbolic manipulations, to verify solutions.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to factor binomials, trinomials, and polynomials by using various techniques (including the greatest common factor, the difference between two squares, and quadratic trinomials). Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.9 Carry out a procedure to perform operations with matrices (including addition, subtraction, and scalar multiplication).

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Matrix
Row
Column
Dimension (size of a matrix)
Matrix addition
Matrix subtraction
Scalar
Scalar multiplication

Continuum of Knowledge
In 8th grade students organize data in matrices or scatterplots as appropriate (8-6.2).

In Elementary Algebra students carry out a procedure to perform operations with matrices (including addition, subtraction, and scalar multiplication).

In Geometry, students build apply transformations (including translation and dilation) to figures in the coordinate plane by using matrices (G-6.4).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Add two matrices of size no larger than a 3x3 matrix.

Subtract two matrices of size no larger than a 3x3 matrix.

Multiply a matrix by a scalar for matrices of size no larger than a 3x3.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Perform the operation or explain why it is not possible.

$$\begin{bmatrix} 7 \\ -1 \end{bmatrix} + \begin{bmatrix} 1 \\ -5 \end{bmatrix}$$

$$\begin{bmatrix} 6 & 0 \end{bmatrix} - \begin{bmatrix} 3 & -4 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix} + \begin{bmatrix} -1 & 1 \\ 5 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix} - \begin{bmatrix} -1 & 1 \\ 5 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix} + \begin{bmatrix} -2 & 1 \\ 8 & -7 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix} - \begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -1 \\ -8 & 7 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -13 \\ 0 & 17 \\ -1 & 20 \end{bmatrix} + \begin{bmatrix} 1 & -4 \\ 6 & -1 \\ 5 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 2 & -13 \\ 0 & 17 \\ -1 & 20 \end{bmatrix} - \begin{bmatrix} 1 & -4 \\ 6 & -1 \\ 5 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 6 & 0 \\ 4 & 1 & -8 \end{bmatrix} + \begin{bmatrix} 9 & -6 & 1 \\ 7 & 0 & -1 \end{bmatrix}$$

$\begin{bmatrix} 2 & 6 \\ 4 & 1 \end{bmatrix} + \begin{bmatrix} 9 & -6 & 1 \\ 7 & 0 & -1 \end{bmatrix}$ (Explain why it is not possible to perform the operation.)

$$\begin{bmatrix} 1 & 7 & -6 \\ 9 & 1 & 10 \\ -11 & 12 & 1 \end{bmatrix} + \begin{bmatrix} 2 & 7 & 19 \\ 3 & 0 & 7 \\ -5 & 12 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 7 & -6 \\ 9 & 1 & 10 \\ -11 & 12 & 1 \end{bmatrix} - \begin{bmatrix} 2 & 7 & 19 \\ 3 & 0 & 7 \\ -5 & 12 & 1 \end{bmatrix}$$

$$2\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$-7\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$4\begin{bmatrix} 3 & 11 & -5 \\ -6 & 0 & 10 \\ 8 & 2 & 1 \end{bmatrix}$$

$$-4\begin{bmatrix} 3 & 11 & -5 \\ -6 & 0 & 10 \\ 8 & 2 & 1 \end{bmatrix}$$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Perform matrix multiplication.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

$$\begin{bmatrix} 3 & -1 \\ 8 & 7 \end{bmatrix} x \begin{bmatrix} -1 & 5 \\ 1 & 3 \end{bmatrix}$$

Misconceptions/Common Errors

Students may forget to distribute the negative to each term in the subtrahend when subtracting matrices. [minuend – subtrahend = difference]

Technology Note
Students may use technology to verify solutions.

Assessment Guidelines

The objective of this indicator is to carry out a procedure to perform operations with matrices (including addition, subtraction, and scalar multiplication). Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-2.10 Represent applied problems by using matrices.

Taxonomy Level
2.1-C
Cognitive Process Dimension: Understand
Knowledge Dimension: Procedural Knowledge

Key Concepts
Matrix
Row
Column
Dimension (size of a matrix)

Continuum of Knowledge
In 8th grade students organize data in matrices or scatterplots as appropriate (8-6.2).

In Elementary Algebra students carry out a procedure to perform operations with matrices (including addition, subtraction, and scalar multiplication).

In Geometry, students build apply transformations (including translation and dilation) to figures in the coordinate plane by using matrices (G-6.4).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Distinguish relevant from irrelevant data.

Represent data using matrices, understanding the meaning of columns and rows in the applied situation.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should able to successfully complete.

Examples 1: The Table A gives the number of people (in thousands) who visited Australia and South Africa in 1998. Figures are rounded to the nearest 10,000. Source: The New York Times, January 14, 2000.

Table A	*To*	
From	**Australia**	**South Africa**
North America	440	190
Europe	950	950
Asia	1,790	200

Represent the tourism data in Table A using a 3x2 matrix.

Example 2: The following is sales data from a department store sales person who works part time.

Sales Data:
Monday: 10 shirts, 8 pants, 10 shorts, 2 hats
Tuesday: 9 shirts, 13 pants, 7 shorts, 0 hats
Wednesday: 15 shirts, 14 pants, 6 shorts, 7 hats

Represent the sales data using a matrix.

Example 3: In a discount department store, similar items sale for the same price. Shirts are $18, pants are $25, shorts are $13, and hats are $10. Represent the price of the items using a matrix.

Example 4: The number of grams of protein, carbohydrates, and fats are given for three samples of food. Each ounce of Food I contains 6 grams of protein, 12 grams of carbohydrates, and 37 grams of fat. Each ounce of Food II contains 10 grams of protein, 5 grams of carbohydrates, and 32 grams of fat. Each ounce of Food III contains 12 grams of protein, 18 grams of carbohydrates, and 77 grams of fat. Represent the number of graphs of protein, carbohydrates, and fats for each ounce of the three food samples using a matrix.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

None noted.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

None noted.

Misconceptions/Common Errors
None noted.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to represent applied problems by using matrices. Therefore, the primary focus of the assessment should be for

students to translate data given in a word problem or table into matrix/matrices.

2007 Mathematics Academic Standards Support Guide for the High School Core Area of Elementary Algebra

This section of the standards support guide addresses Elementary Algebra Standard EA-3 and provides additional information about its indicators EA-3.1 thorough EA-3.8.

Standard EA-3: The student will demonstrate through the mathematical processes an understanding of relationships and functions.

Indicators

EA-3.1 Classify a relationship as being either a function or not a function when given data as a table, set of ordered pairs, or graph.

EA-3.2 Use function notation to represent functional relationships.

EA-3.3 Carry out a procedure to evaluate a function for a given element in the domain.

EA-3.4 Analyze the graph of a continuous function to determine the domain and range of the function.

EA-3.5 Carry out a procedure to graph parent functions (including $y = x, y = x^2, y = \sqrt{x}, y = |x|,$ and $y = \frac{1}{x}$).

EA-3.6 Classify a variation as either direct or inverse.

EA-3.7 Carry out a procedure to solve literal equations for a specified variable.

EA-3.8 Apply proportional reasoning to solve problems.

EA-3.1 Classify a relationship as being either a function or not a function when given data as a table, set of ordered pairs, or graph.

Taxonomy Level
2.3-B
Cognitive Process Dimension: Understand
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Function
Relationship

Continuum of Knowledge
In 8th grade, students translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1). They also classify relationships between two variables in graphs, tables, and/or equations as either linear or nonlinear (8-3.5).

In Elementary Algebra, students classify a relationship as being either a function or not a function when given data as a table, set of ordered pairs, or graph (EA-3.1).

In Intermediate Algebra, students carry out procedures to perform operations on polynomial functions (including $f(x) + g(x)$, $f(x) - g(x)$, $f(x) \cdot g(x)$, and $f(x)/g(x)$) (IA-2.5). They also apply a procedure to write the equation of a composition of given functions (IA-2.6). In addition, students carry out a procedure to graph discontinuous functions (including piecewise and step functions) (IA-2.9) and determine the domain and range of discontinuous functions (including piecewise and step functions) (IA-2.10).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use the definition of a function to classify a set of ordered pairs in a table or list as a function or not a function.

Use the definition of a function to classify a set of ordered pairs in a mapping as a function or not a function.

Use the vertical line test and the graph of a continuous relationship to classify the relationship as a function or not a function.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Classify the relationship shown in the table below as a function or not a function.

X	Y
1	6
2	8
2	10
3	12
4	16

Answer: not a function

Classify the relationship shown in the table below as a function or not a function.

X	Y
-3	-4
-1	0
1	4
3	8
5	12

Answer: function

Classify the relationship shown in the table below as a function or not a function.

X	Y
-6	3
-3	-2
0	5
3	-8
6	12

Answer: function

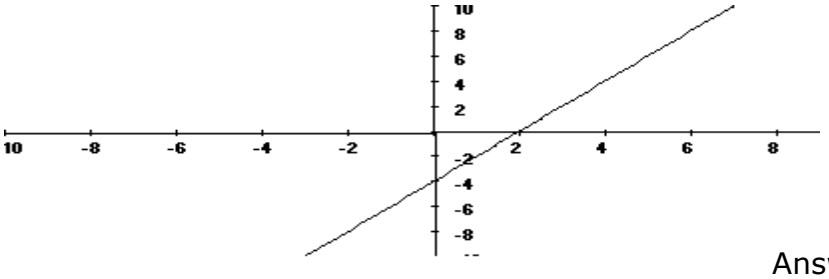
Classify the relationships shown below a function or not a function.

{(0,2), (3,7), (4,10), (6,15), (8,10)} Answer: function

{(0,6), (3,6), (4,6), (6,6), (8,6)} Answer: function

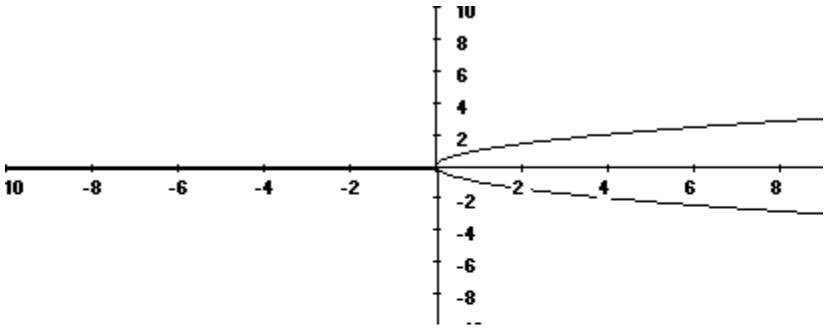
{(5,2), (5,7), (5,10), (5,15), (5,10)} Answer: not a function

Classify the relationship shown on the graph below as a function or not a function.



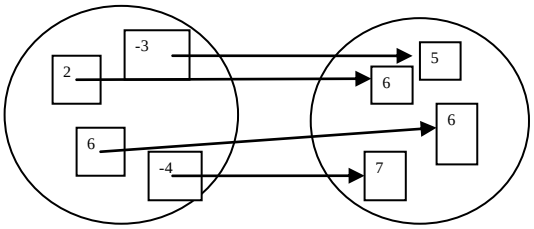
Answer: function

Classify the relationship shown on the graph below as a function or not a function.



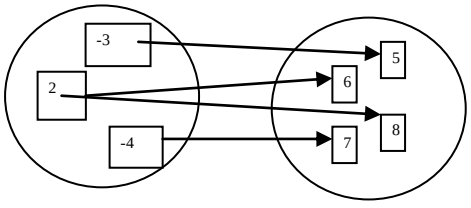
Answer: not a function

Classify the relationship shown on the mapping below as a function or not a function.



Answer: function

Classify the relationship shown on the mapping below as a function or not a function.



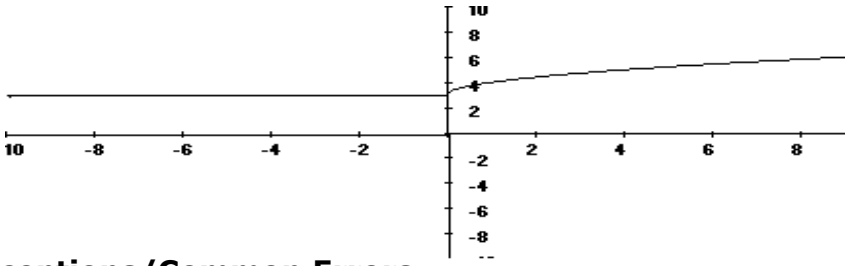
Answer: not a Function

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Classify piecewise relationships as a function or not a function.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Classify the relationship shown on the graph below as a function or not a function.



Misconceptions/Common Errors
Students may not understand that two ordered pairs with the same y-coordinate but different x-coordinates are possible ordered pairs for a function. Students may confuse discrete and continuous data. Tables, lists, and mappings represent discrete data, unless the information provided with the table indicates that the given points are points on a continuous graph. When given a graph, students differentiate between discrete and continuous data more easily.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is for the student to <u>understand</u> the definition of a function so that the student can <u>classify</u> a relationship as being either a function or not a function when given data as a table, set of ordered pairs, or graph. In addition to classifying relationships as functions or not functions, students should be able to exemplify, compare, or explain relationships that are functions or not functions.

EA-3.2 Use function notation to represent functional relationships.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Function Notation

Continuum of Knowledge
In 8th grade, students translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1). They also classify relationships between two variables in graphs, tables, and/or equations as either linear or nonlinear (8-3.5).

In Elementary Algebra, students will use function notation to represent functional relationships (EA-3.2).

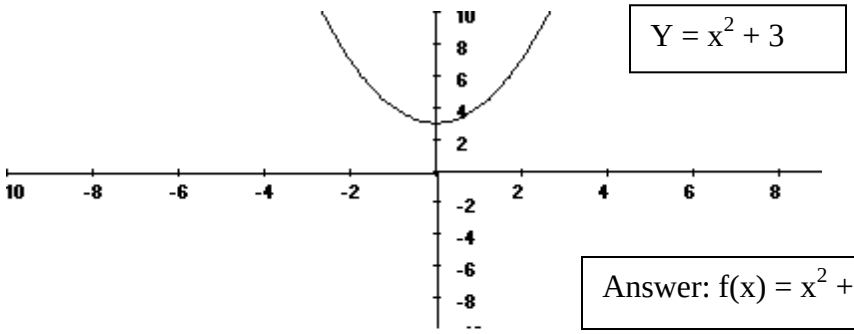
In Intermediate Algebra, students carry out procedures to perform operations on polynomial functions (including $f(x) + g(x)$, $f(x) - g(x)$, $f(x) \cdot g(x)$, and $f(x)/g(x)$) (IA-2.5).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use function notation to represent functions given as an equation, graph, or described in words.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Use function notation to represent the function shown in the graph below.



$Y = x^2 + 3$

Answer: $f(x) = x^2 + 3$

Use function notation to represent the function described below.

The temperature of an object on the Celsius scale is 5/9 the difference between the Fahrenheit temperature (t) and 32° F.
Answer: F(t) = 5/9(t-32)

Given y = 1/x. Express this equation in function notation.
Answer: f(x) = 1/x

Which of the following expresses the relationship described below in function notation?
"q is a function of r and 2 times r equals q"

a. q(r) = 2q
b. q(r) = 2r
c. r(q) = 2q
d. r(q) = 2r Answer: b
e.

Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Derive the functional relationship.

Examples of Non-Essential Tasks

The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Use function notation to represent the linear function shown in the table below.

X	Y or f(x)
1	6
2	8
3	10
4	12
5	14

Answer: f(x) = 2x + 4

Use function notation to represent the linear functional relationship represented below containing the set of ordered pairs (x, y) or (x, f(x)).

{(0, 0), (3,-9), (4,-12), (-6,18), (-8,24)} Answer: f(x) = -3x

Misconceptions/Common Errors

Students may not understand that function notation defines a function in terms of an independent variable, but does not specify the symbol used to represent the dependent variable.

Technology Note
When graphing a function that is defined in function notation using technology, "y =" is used even though the dependent variable may not be "y".

Assessment Guidelines
The objective of this indicator is for the student to apply conceptual knowledge to use function notation to represent functional relationships.

EA-3.3 Carry out a procedure to evaluate a function for a given element in the domain.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Value of a Function
Domain Value
Range Value
Substitution
Evaluation

Continuum of Knowledge
In 8th grade, students apply formulas to determine the exact (*pi)* circumference and area of a circle (8-5.4) and apply formulas to determine the perimeters and areas of trapezoids (8-5.5). To determine these measurements, students substitute values for variables in appropriate formulas.

In Elementary Algebra, students carry out a procedure to evaluate a function for a given element in the domain (EA-3.3).
.
In Precalculus, students apply a procedure to evaluate trigonometric expressions. (PC-5.6). Though not specifically stated as an indicator, this essential skill is used in all core areas.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Substitute a given value for the independent variable and use the order of operations to evaluate the function for the given element.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Find the value of the function $f(x) = 4x + 6$ for $x = -2$.

Given $g(t) = 2t - 6$, evaluate $g(2)$.

For $y = x + 2$, what is the value of y when $x = -4$?
Find the value of y for $x = ½$, if $y = 1/x$.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Evaluate a function for elements in the domain with variable values.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Evaluate $g(t) = 2t - 6$ for $t = a$.

Misconceptions/Common Errors
Students may think that for $g(t) = 2t - 6$ that $g(t)$ means g multiplied by t.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure to evaluate a function for a given element in the domain.

EA-3.4 Analyze the graph of a continuous function to determine the domain and range of the function.

Taxonomy Level
4.1-C
Cognitive Process Dimension: Analyze
Knowledge Dimension: Procedural Knowledge

Key Concepts
Domain
Range

Continuum of Knowledge
In 8th grade, students use ordered pairs, equations, intercepts, and intersections to locate points and lines in a coordinate plane (8-4.2).

In Elementary Algebra, students analyze the graph of a continuous function to determine the domain and range of the function (EA-3.4).

In Intermediate Algebra, students carry out a procedure to determine the domain and range of discontinuous functions (including piecewise and step functions) (IA-2.10).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Determine the set of x-coordinates of points on the graph.

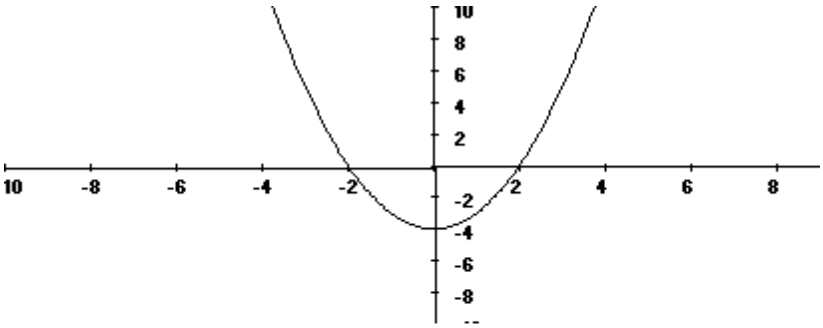
Describe the set of x-coordinates using words or mathematical expressions to specify the domain of a continuous function.

Determine the set of y-coordinates of points on the graph.

Describe the set of y-coordinates using words or mathematical expressions to specify the range of a continuous function.

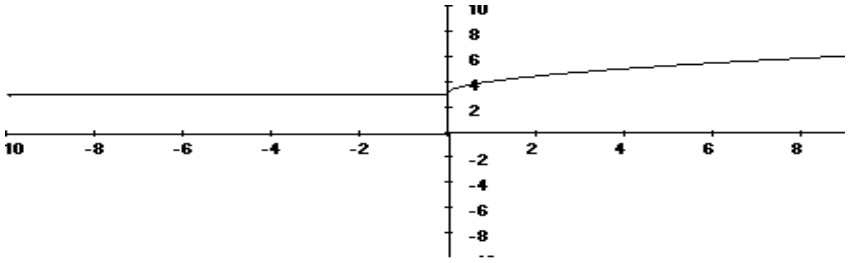
Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Analyze the graph below to determine the domain and range of the function.



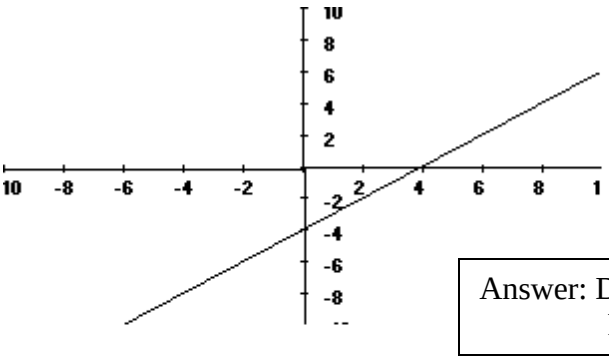
Answer: Domain: all real numbers
Range: $y \geq -4$

Analyze the graph below to determine the domain and range of the function.



Answer: Domain: all real numbers
Range: $y \geq 3$

Analyze the graph below to determine the domain and range of the function.

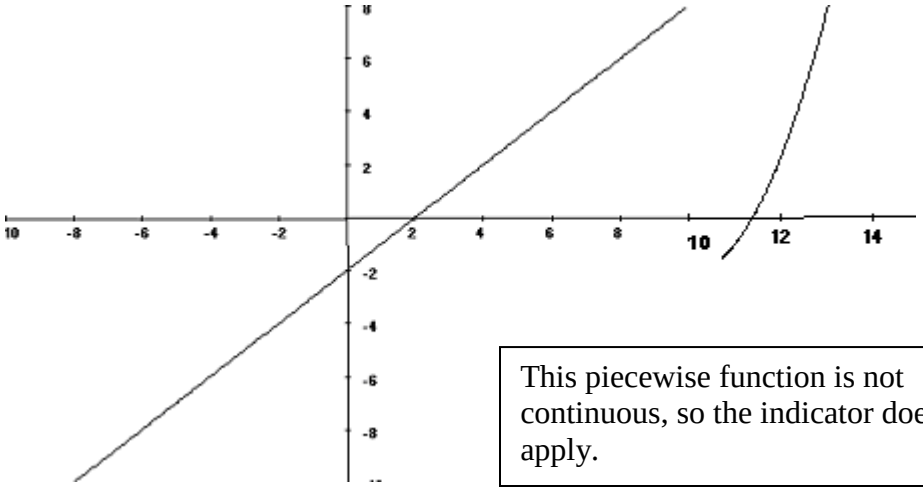


Answer: Domain: all real numbers
Range: all real numbers

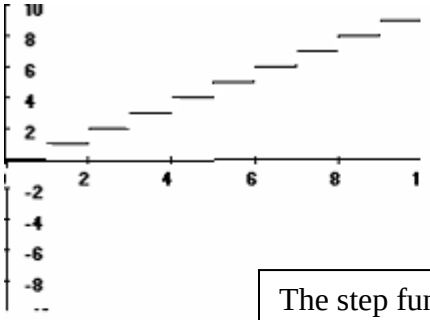
Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Analyze the graph of non-continuous functions that are piecewise, including step functions.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.



This piecewise function is not continuous, so the indicator does not apply.



The step function (y = [x]) shown at the left is not continuous, so the indicator does not apply. The greatest integer function is not continuous.

Misconceptions/Common Errors
Students sometimes reverse the domain and range of functions.

Technology Note
Students may enter a function, look a graph, and use the trace feature. Students may use the table feature.

Assessment Guidelines
The objective of this indicator is for the student to analyze the graph of a continuous function to determine the domain and range of the function.

EA-3.5 Carry out a procedure to graph parent functions (including $y = x, y = x^2, y = \sqrt{x}, y = |x|,$ and $y = \frac{1}{x}$).

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
x-coordinate
y-coordinate
Ordered pair
Coordinate plane

Continuum of Knowledge
In 8th grade, students use ordered pairs, equations, intercepts, and intersections to locate points and lines in a coordinate plane (8-4.2).

In Elementary Algebra, students carry out a procedure to graph parent functions (including $y = x, y = x^2, y = \sqrt{x}, y = |x|,$ and $y = \frac{1}{x}$) (EA-3.5).

In Intermediate Algebra, students carry out a procedure to graph translations of parent functions (including $y = x, y = x^2, y = \sqrt{x}, y = |x|,$ and $y = \frac{1}{x}$) (IA-2.7).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use the equation of a parent function to determine a set of ordered pairs that lie on the graph of the equation, locate those points in a coordinate plane, and sketch a continuous graph by analyzing the pattern of the points plotted.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Sketch a graph of y = x in a coordinate plane.

Sketch a graph of $y = x^2$ in a coordinate plane.

Sketch a graph of $y = \sqrt{x}$ in a coordinate plane.

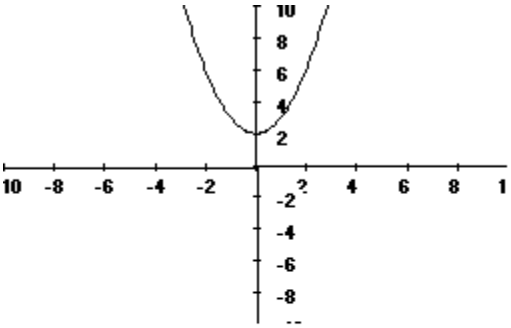
Sketch a graph of y = |x| in a coordinate plane.

Sketch a graph of y = $\frac{1}{x}$ in a coordinate plane.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph transformations of parent functions

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.



This is a translation of $y = x^2$ ($y = x^2 + 2$). It is not essential for students to graph translations of parent functions.

Misconceptions/Common Errors
None noted

Technology Note
If students graph y = 1/x in connected mode, then the calculator will incorrectly connect the parts of the graph in quadrant I and quadrant III. A more accurate representation is produced when students graph in the unconnected mode.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure to graph parent functions (including $y = x, y = x^2, y = \sqrt{x}, y = |x|,$ and $y = \frac{1}{x}$).

EA-3.6 Classify a variation as either direct or inverse.

Taxonomy Level
2.3-B
Cognitive Process Dimension: Understand
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Direct variation
Inverse variation

Continuum of Knowledge
In 8th Grade, students apply ratios, rates, and proportions (8-2.7) and use proportional reasoning and the properties of similar shapes to determine the length of a missing side (8-5.1).

In Elementary Algebra, students will classify a variation as either direct or inverse.

In Geometry, students use scale factors to solve problems involving scale drawings and models (G-2.6). They also apply congruence and similarity relationships among triangles to solve problems (G-3.8) and apply congruence and similarity relationships among shapes (including quadrilaterals and polygons) to solve problems (G-4.6).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Understand the definition of direct variation

Understand the definition of inverse variation

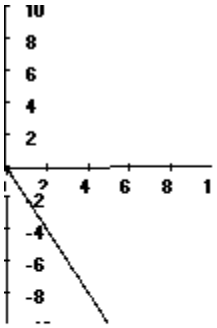
Classify a variation as direct or inverse.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Classify each of the following as direct variation or inverse variation.

The circumference C of a circle and its diameter d are related by the equation $C = \pi d$. Answer: direct variation

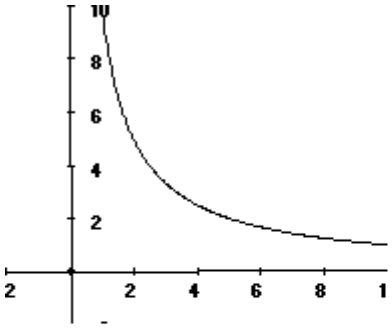
$XY = 20$ Answer: inverse variation



Answer: direct variation

Y = 4x

Answer: direct variation



Answer: inverse variation

A car is traveling at a constant speed of 50 miles/hour. The distance that the car travels is related to the time by the equation d = 50 t, where t is in hours.

Answer: direct variation

Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Write the equation for a direct variation or inverse variation

Examples of Non-Essential Tasks

The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Y varies directly with x and y = 12 when x = 3. Write an equation that relates x and y.

Misconceptions/Common Errors

Students may reverse the definitions. They may also have difficulty classifying some forms of equations.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is for the student to classify a variation as either direct or inverse. In addition to classifying variations, students should be able to exemplify, explain, or compare variations.

EA-3.7 Carry out a procedure to solve literal equations for a specified variable.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Solving equations
Literal equations

Continuum of Knowledge
In 8th grade, students apply procedures to solve multistep equations (8-3.4).

In Elementary Algebra, students carry out a procedure to solve literal equations for a specified variable. (EA-3.7).

In Intermediate Algebra and Precalculus, students use this skill to write equations to solve optimization problems. In Precalculus, students carry out a procedure to write a rule for the inverse of a function, if it exists (PC-2.9).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use inverse operations to solve literal equations for a specified variable that may involve multiple steps.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Solve ax = b+ cd for c.

P = 2l + 2w, solve for w.

E = MC^2, solve for M.

I = PRT, solve for T

V = IR, solve for I

D = RT, solve for R

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve equations for a variable that requires finding roots of the equation.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

A = π*r^2, solve for r.

Misconceptions/Common Errors
Students may not isolate the variable.
Students may stop at an intermediate step.

Technology Note
Solving literal equations is an essential skill for using spreadsheets for solving problems.
Using a spreadsheet to calculate pay with or without overtime.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure to solve literal equations for a specified variable. The solution may involve multiple steps.

EA-3.8 Apply proportional reasoning to solve problems.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Ratio
Proportion

Continuum of Knowledge
In 8th grade, students apply ratios, rates, and proportions (8-2.7) and use proportional reasoning and the properties of similar shapes to determine the length of a missing side (8-5.1).

In Elementary Algebra, students apply proportional reasoning to solve problems.

This essential skill is used in all subsequent study of mathematics.

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Use proportional reasoning to solve problems.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

The variables x and y vary directly and y = 35 when x = 7. Find the value of y when x = 9.

The distance traveled by a car moving at a constant speed varies directly with the length of time it travels. If the car travels 172 miles in 4 hours, how many miles will it travel in 9 hours?

An equation that reflects the relationship between x and y is x/y = 40. Find the value of x when y = 5.

A statue is to be constructed using a 10:1 (height of statue:height of person) scale. If the person to be depicted is 76 inches tall, how tall should the statue be built?

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Determine the constant of proportionality for contextual, real-world problems.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

The table below shows heights of people and their armspan (distance between fingertips with arms extended perpendicular to body). Approximate the constant of proportionality and write an equation that summarizes the relationship between these two measurements, if one exists.

Height (H) in inches	Armspan (A) in inches
64	68
71	73
62	60
68	72
65	63

Misconceptions/Common Errors
None noted

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is for the student to use proportional reasoning to solve problems.

2007 Mathematics Academic Standards Support Guide for the High School Core Area of Elementary Algebra

This section of the standards support guide addresses Elementary Algebra Standard EA-4 and provides additional information about its indicators EA-4.1 thorough EA-4.10.

Standard EA-4: The student will demonstrate through the mathematical processes an understanding of the procedures for writing and solving linear equations and inequalities.

Indicators

EA-4.1 Carry out a procedure to write an equation of a line with a given slope and a *y*-intercept.
EA-4.2 Carry out a procedure to write an equation of a line with a given slope passing through a given point.
EA-4.3 Carry out a procedure to write an equation of a line passing through two given points.
EA-4.4 Use a procedure to write an equation of a trend line from a given scatterplot.
EA-4.5 Analyze a scatterplot to make predictions.
EA-4.6 Represent linear equations in multiple forms (including point-slope, slope-intercept, and standard).
EA-4.7 Carry out procedures to solve linear equations for one variable algebraically.
EA-4.8 Carry out procedures to solve linear inequalities for one variable algebraically and then to graph the solution.
EA-4.9 Carry out a procedure to solve systems of two linear equations graphically.
EA-4.10 Carry out a procedure to solve systems of two linear equations algebraically.

EA-4.1 Carry out a procedure to write an equation of a line with a given slope and a y-intercept

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Slope
y-intercept
Slope-intercept form

Continuum of Knowledge
In 7th grade, students analyze tables and graphs to determine the rate of change among and between quantities (7-3.2). They also develop an understanding of slope as a rate of change (7-3.3). In 8th grade, students identify the slope (8-3.7) and the y-intercept (8-3.6) from a graph, equation and/or table. Also in 8th grade, students represent algebraic relationships with equations and inequalities (8-3.2).

In elementary Algebra, students carry out a procedure to write an equation of a line with a given slope and a y-intercept

In Intermediate Algebra, students carry out a procedure to write an equation of a quadratic function when given its roots (IA-3.6).

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Find the slope of a linear function from a graph or table of values.

Recognize and use the slope intercept form of a linear equation

Work with integral and fractional values for the slope and y-intercept

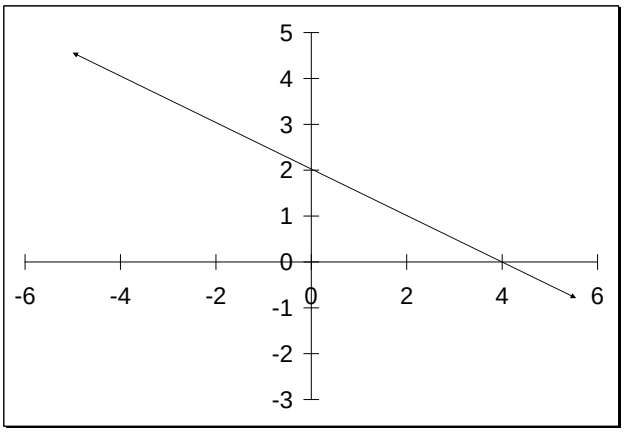
Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

- Write the equation for the linear function with a slope of $\frac{1}{2}$ and a y-intercept of $\frac{-1}{4}$

- Write the equation of the line whose slope is -4 and passes through the (0,-2)

- Write the equation for the linear function with a slope of -5 and whose graph crosses the y-axis at 3.

- Write the equation of the line for the graph given below.



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

None noted

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

None noted

Misconceptions/Common Errors
Students may not recognize that the value of b in the slope-intercept form must be the y-intercept

Students confuse the x-intercept $(x,0)$ with the y-intercept $(0,y)$

When slope-intercept form is given as $y = b + mx$ students confuse the slope and y-intercept

Students may not recognize $y = b + mx$ as an equivalent form of $y = mx + b$. Also students are confused when variables other than m and b are used to represent the slope and y-intercept.

Technology Notes
Students may use a graphing utility to graph their resulting equation. They can use the graph to verify that the line has the given slope and crosses at the given y-intercept. This gives students additional practice in determining the slope and y-intercept from a graph.

Assessment Guidelines
This objective of this indicator is for the student to carry out a procedure to write a linear equation given a slope and y-intercept. Therefore, the primary focus should be on students using slope-intercept form to write such equations. As indicated by the Bloom's verb carry out, students apply a procedure to a familiar task. Students may need to use appropriate procedures to determine the slope and y-intercept from the given information in order to write the equation of the line.

EA-4.2 Carry out a procedure to write an equation of a line with a given slope passing through a given point

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Slope
Slope-intercept form
Point-slope form

Continuum of Knowledge

In 6th grade, students represent the location of a point with an ordered pair (6-4.1). In 7th grade, students examine slope as a rate of change (7-3.3). In 8th grade, students identify the slope (8-3.7), use ordered pairs to locate a point in the coordinate plane (8-4.2) and represent algebraic relationships with equations and inequalities (8-3.2).

In Elementary Algebra, students carry out a procedure to write an equation of a line with a given slope passing through a given point.

This essential skill is necessary in all subsequent study of mathematics.

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Find the slope of a linear function from a graph or table of values.

Recognize and use the slope-intercept form or point-slope form of a linear equation in order to write the equation.

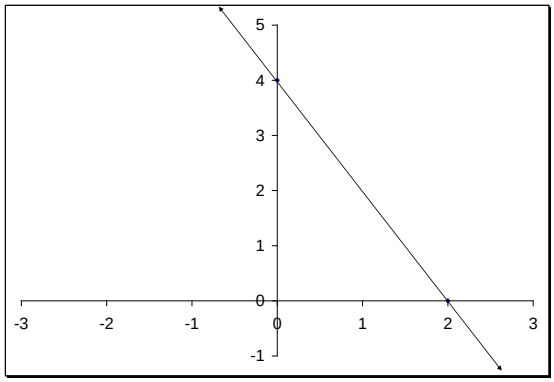
Work with integral and fractional values for the slope and the coordinates of the given point

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> Write the equation of a line passing through the point (-1,6) with a slope of -4

Write the equation of a line whose slope is $\frac{-3}{4}$ and passes through the point $(-2,5)$

Write the linear equation for the graph below.



Write the equation of the line that is parallel to the line $y = -4x + 3$ and passing through the point (1, 2)

Write the equation of the line that is perpendicular to the line $2x - 3y = 6$ and passes through the point (4,-1)

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

None noted

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

None noted

Misconceptions/Common Errors
Students using the slope-intercept form may substitute the y value of the given point in for the value of *b* although the given point may not represent the y-intercept.

Students using the point-slope form may not recognize that $x_1, y_1 \text{ and } m$ represent constants and x and y represent variables.

Technology Notes
Students may use a graphing utility to graph their resulting equation. They can use the graph to verify that the line has the given slope. While on the graph screen, students can verify that the line crosses at the given point by using the value function under the CALC menu.

Assessment Guidelines
This objective of this indicator is for the student to carry out a procedure for writing the equation of line with a given slope and a given point. Therefore, the primary focus should be on students using such procedure to write the equations.

EA-4.3 Carry out a procedure to write an equation of a line passing through two points

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Slope
y-intercept
Slope-intercept form
Point-slope form

Continuum of Knowledge
In 8th grade, students identify the slope of a linear equation from a graph, equation, and/or table (8-3.7).

In Elementary Algebra, students carry out a procedure to write an equation of a line passing through two points

This essential skill is necessary in all subsequent study of mathematics.

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Find the slope of a linear function from a graph or table of values.

Use the slope-intercept form or point-slope form of a linear equation in order to write the equation of a line

Work with integral and fractional values of the slope and coordinates

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

- Write the equation of the line passing through the points $(-2.-1)$ and
- Write a linear equation for the line passing through the points $\left(\frac{2}{3},4\right)$ and $\left(\frac{-1}{3},-2\right)$

- Write a linear equation to represent the data in the table of values below.

X	Y
-1	2
0	-1
1	-4
2	-7
5	-10

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Write linear equations for two points containing all fractional coordinates.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Write the equation of the line passing through the points $\left(\frac{-3}{4},\frac{2}{3}\right)$ and $\left(\frac{-1}{2},\frac{4}{5}\right)$.

Misconceptions/Common Errors

Students determine the slope using the formula $m=\frac{x_2-x_1}{y_2-y_1}$

Students determine the slope using the formula $m=\frac{y_2-y_1}{x_1-x_2}$

Students using the slope-intercept form may substitute the y value of the given point in for the value of *b* although the given point may not represent the y-intercept.

Students using the point-slope form may not recognize that $x_1, y_1 \text{ and } m$ represent constants and x and y represent variables.

Technology Notes
Students may use a graphing utility to graph their resulting equation. They can use the graph to verify that the line has the given slope. While on the graph screen, students can verify that the line crosses at the given points by

using the value function under the CALC menu.

Assessment Guidelines
This objective of this indicator is for the student to carry out a procedure to write the equation of line passing through two points. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-4.4 Use a procedure to write an equation of a trend line from a given scatterplot

Taxonomy Level
3.2-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Trend Line
Scatterplot
Correlation
Slope
Slope-intercept form
Point-slope form

Continuum of Knowledge

In 8th grade, students generalize the relationship between two sets of data by using scatterplots and lines of best fit (8-6.1) and organize data in matrices or scatterplots as appropriate (8-6.2).

In elementary algebra, students use procedure to write an equation of a trend line from a given scatterplot

In Data and Probability, students organize and interpret data by using scatterplots (DA-3.2, DA-3.3) then classify the scatterplot by shape (DA-3.5). Students also determine a trend line using visual approximation and technology (DA-3.7, DA-3.8).

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Recognize the correlation of data represented by a scatterplot as being positive, negative and no correlation

Find the slope of a linear function from a graph or table of values.

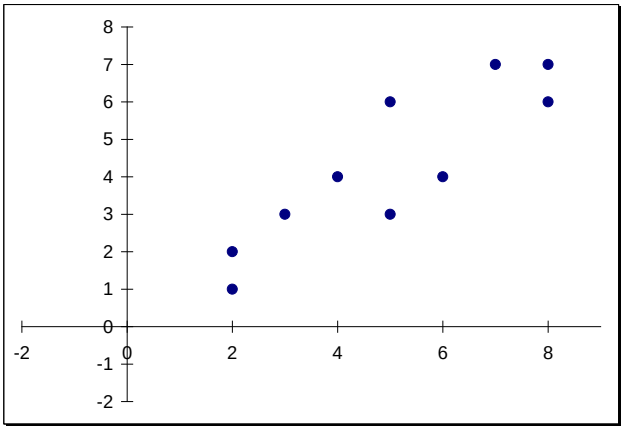
Use the slope-intercept form or point-slope form of a linear equation in order to write the equation of a line

Determine the reasonableness of a line of fit using visual approximation.

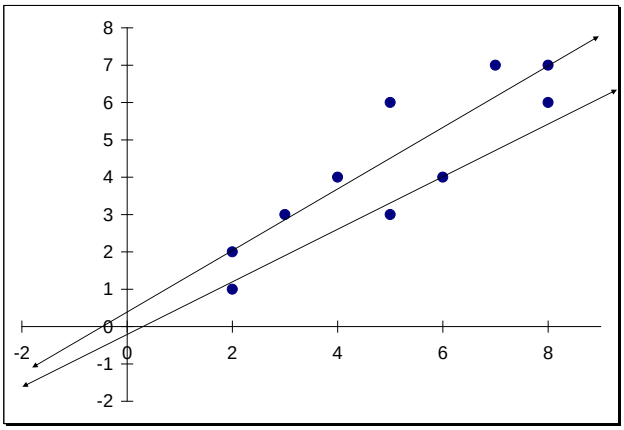
Determine which axis represents the independent and dependent variables

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Write the equation of the trend line for the scatterplot shown below.



Write the equation for the trend line that is the most reasonable line of fit for the data graphed in the scatterplot below.



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Create scatterplots with more than 10 points using manual graphing methods.

Use statistical methods such as r and r^2 to determine the preciseness of the correlation

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> Sketch the scatterplot then write an equation for the trend line that the most reasonable line of fit.

X	2	-1	3	4	-2	5	7	10	8	7	-6	-5	3	-9	4	6	11	12
Y	0	3	5	8	-6	8	3	-7	4	1	2	-3	5	9	10	8	-8	7

> The correlation coefficient, r, for a given set of data is 0.9. Explain the meaning of this value in terms of the relationship between variables.

Misconceptions/Common Errors
Students may consider a line that clearly passes through two points to be the trend line even though the line does not meet the additional criteria for a trend line.

Students may confuse the terms trend line (line of fit) with a line of best fit. A trend line (line of fit) is an approximation of the line of best fit. The line of best fit is determined using statistical methods involving r and r^2 to determine the precise of the correlation.

Technology Notes
Many data collection activities will result in a large set of data points. Technology may be used to create these types of graphs instead of manual graphing methods.

Assessment Guidelines
This objective of this indicator is for the student to use a procedure to write a trend line for a given scatterplot. Therefore, students should expect to use a procedure in an unfamiliar task or situation. Although the primary focus of the indicator is on the procedure of writing the trend line, students need to have an understanding of what constitutes a trend line.

EA-4.5 Analyze a scatterplot to make predictions

Taxonomy Level
4.1-C
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Prediction
Scatterplot
Correlation
Independent variable
Dependent variable

Continuum of Knowledge
In 8th grade, students generalize the relationship between two sets of data by using scatterplots and lines of best fit (8-6.1) and organize data in matrices or scatterplots as appropriate (8-6.2).

In elementary algebra, students analyze a scatterplot to make predictions

In Data and Probability, students organize and interpret data by using scatterplots (DA-3.2, DA-3.3) then classify the scatterplot by shape (DA-3.5). Students also determine a trend line using visual approximation and technology (DA-3.7, DA-3.8).

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Recognize the correlation of data represented by a scatterplot as being positive, negative and no correlation

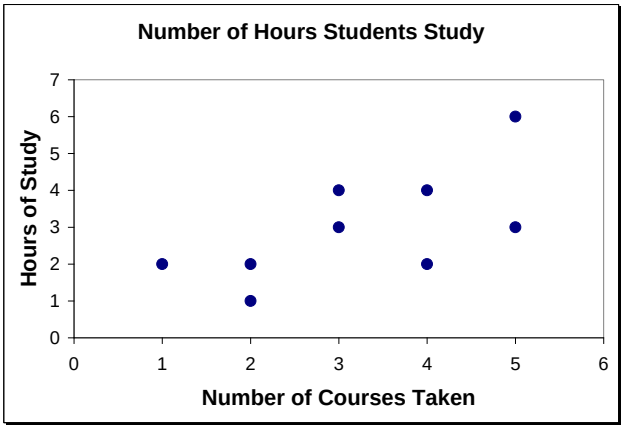
Determine the meaning of the slope, y-intercept and coordinates in a contextual problem.

Use the concept of slope as a rate of change to make predictions

Determine which axis represents the independent and dependent variables

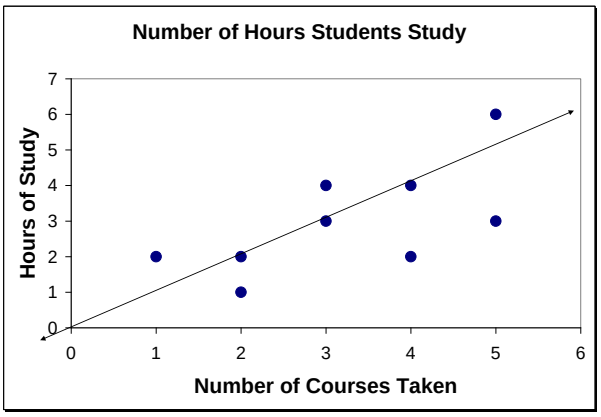
Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

If this graph represents hours studied per week, what is a reasonable prediction for the number of hours studied for six courses taken?



Suitable answers are between 5 and 6. Teacher may determine a suitable range for answers.

If the graph below represents the hours a student studies per week, what is a reasonable prediction for the number of hours a student studies for seven courses?



Note: We have to be careful when extrapolating. Hours in a week is a limited resource with an upper limit, so we can expect to lose linearity at some point.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

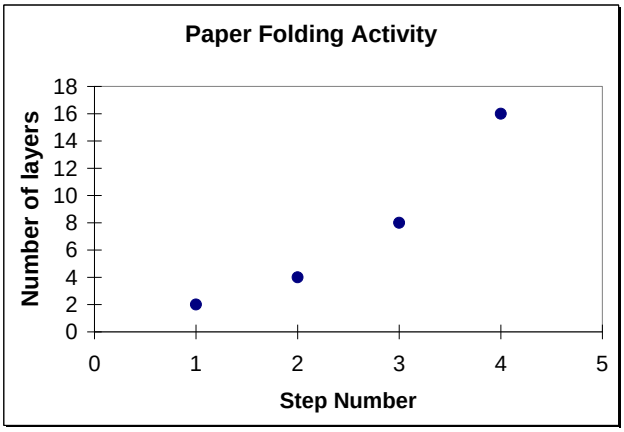
Analyze a scatterplot that resembles non-linear data

Make predictions using data that has no correlation

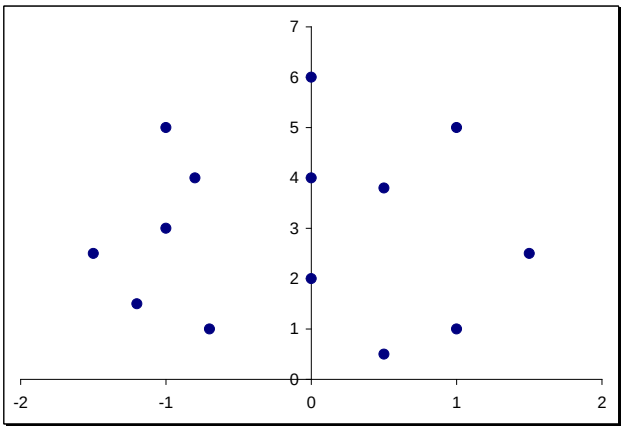
Write the equation for the trend line in order to make their predictions. Students may only need to draw a trend line then make their predictions

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> What is a reasonable prediction for the number of layers when you are on step 7 of this paper folding activity?



> What type of correlation is represented by the data? How effective would this data be in making a prediction? Explain your answer.



Misconceptions/Common Errors
Students may assume that the scales of the axes are always in increments of one. This has an effect on the prediction values.

Students should be very careful when extrapolating. Unless there is a very good reason to expect the relationship to continue to be linear beyond our data, we should not assume it is linear beyond given data.

Technology Notes
Many data collection activities will result in a large set of data points. Technology should be used to create these types of graphs instead of manual graphing methods which may allow for more time to analyze their meaning.

One of the difficulties students have when using a graphing utility to create a scatterplot is setting the viewing window. Students need sufficient practice performing this skill.

Assessment Guidelines
This objective of this indicator is for the student to analyze a scatterplot to make predictions. Therefore, the primary focus of the assessment should be for students to determine the relationship of the data, if any, and determine how this relationship affects the overall structure of the scatterplot. Students should be able to make reasonable estimates based on this analysis. Although writing the equation of the trend line may be helpful, the focus of this indicator is to analyze.

EA-4.6 Represent linear equations in multiple forms (including point-slope, slope-intercept, and standard)

Taxonomy Level
2.1-C
Cognitive Process Dimension: Understand
Knowledge Dimension: Procedural Knowledge

Key Concepts
Point-slope form
Slope-intercept form
Standard form (will vary from text to text)

Continuum of Knowledge
In 8th grade, students identify the coordinates of the *x*- and *y*-intercepts (8-3.6). Students also translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1). The forms of these linear equations include the slope-intercept form and the standard form.

In Elementary Algebra, students represent linear equations in multiple forms (including point-slope, slope-intercept, and standard).

This essential skill is necessary in all subsequent study of mathematics.

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Recognize and use forms of linear equations such as point-slope, slope-intercept and standard.

Use algebraic techniques to translate linear equations from one form to another

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Represent the equation $2x+5y=-10$ in slope-intercept form.

Represent the equation $-3x-6y-9=0$ in slope-intercept form.

Which of the following is an equivalent form of $y=\frac{-2}{3}x-4$?

a. $2x+3y=-4$
b. $-2x+3y=-12$
c. $2x+3y=-12$
d. $-2x+3y=-4$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

None noted

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

None noted

Misconceptions/Common Errors
Students may not understand that linear equations represented in different forms can represent the same line. For example, $y = -2x + 5$ is the same line as $2x + y = 5$.

Technology Notes
Many graphing utilities require that the equation be converted to slope-intercept form before entering the equation into the calculator.

Exploring the graphs of linear equations in various forms may be used to address the misconception that linear equations represented in different forms can represent the same line.

Assessment Guidelines
This objective of this indicator is for the student to represent linear equations in multiple forms. Therefore, the primary focus of the assessment should be for students to become fluent in the algebraic techniques necessary to translate equations to multiple forms.

EA-4.7 Carry out procedures to solve linear equations for one variable algebraically

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Linear equation
Solution

Continuum of Knowledge
In 6th grade, students solve one step linear equations with whole number solutions and coefficients (6-3.5). In 7th grade, students solved two step equations and inequalities (7-3.4). In 8th grade, students solved multi-step equations (8-3.4)

In elementary algebra, students carry out procedures to solve linear equations for one variable algebraically.

The process is a foundation for student's work with solving other types of equations such as quadratic (IA-3.3) and polynomial equations (IA-4.3) for an indicated variable.

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Use appropriate algebraic techniques to solve for a given variable

Understand which algebraic techniques or properties were applied in order to get the resulting equivalent linear equation

Solve linear equation involving one step, two steps, distributive property, variables on both sides, fractional coefficients, decimals and the collecting of like terms.

Solve linear equations that result in one solution, no solution or infinitely many

Check their solutions using an appropriate method

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Solve. $-2(x-5)=3x+4$

Solve. $6x-x=-10$

Solve. $\frac{2}{3}(6x-3)=4x+1$

Solve. $3(x+2)=3x+4$

In which step did the first error occur?

$$3(2x-1)=6$$
$$\textit{Step } 1: \quad 6x-3=6$$
$$\textit{Step } 2: \quad 6x=3$$
$$\textit{Step } 3: \quad x=\frac{1}{2}$$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve equations involving radical notation

Solve rational equations with variables in the denominator that are beyond simple proportional reasoning problems.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Solve $\frac{3}{x+2}=\frac{5}{2x-1}$

Solve $\sqrt[3]{x-2}=5$

Misconceptions/Common Errors
Students do not fully isolate the variable. In this example, student may stop at $6x=9$ and incorrectly conclude that $x=9$

$$3(2x-1)=6$$
$$6x-3=6$$
$$6x=9$$
$$x=9$$

Student may misuse the equality symbol by setting up a string of equalities such as $2x+1=-5=2x=-6=x=-3$.

Students may have the misconception that the variable should always be on the left side of the equals sign. This can cause confusion for students when problems are presented in the form $-3=x$.

Technology Notes
When checking their solution by direct substitution, students may use a graphing utility to verify their computations.

Student may check their solutions by using the intersect feature on their graphing utility. For example, given $2x+1=-5$, students would determine where the graphs of $y=2x+1$ and $y=-5$ intersect.

One of the difficulties students may have when using a graphing utility to determine the point of intersection is setting an appropriate viewing window that clearly displays the point of intersection. Students need sufficient practice performing this skill.

The table of values can also be used to verify for which x value are the y values of both equations equal. The table will need to be set in order to display the appropriate values.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure to solve linear equations. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-4.8 Carry out a procedure to solve linear inequalities for one variable algebraically and then to graph the solution

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Linear inequality
Solution
Graphing on the number line
Graphing on a coordinate plane
Boundaries

Continuum of Knowledge
In 6th grade, students represented algebraic relationships with simple inequalities (6-3.3). In 7th grade, students solved two step inequalities (7-3.4) and represent their solutions on a number line (7-3.5). In 8th grade, students represented algebraic algebraically relationships with inequalities and solved multi-step equations but not inequalities.

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Use appropriate algebraic techniques to solve for a given variable

Understand which algebraic techniques and properties were applied in order to get the resulting equivalent linear inequality

Solve linear inequalities involving one step, two steps, distributive property, variables on both sides, fractional coefficients, decimals and the collecting of like terms.

Check their solutions using an appropriate method

Graph solutions on a number line using open or closed circles and shading the appropriate region

Solve inequalities for a given variable

Graph inequalities on a coordinate plane

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Solve the inequality then graph the solution. $11 > \frac{-1}{3}m$

Solve the inequality then graph the solution. $-3t + 15 \leq 2t$

Solve the inequality then graph the solution. $7 - 2(x - 3) \geq 25$

Solve the inequality then graph the solution. $7.2 - 2.1b < 4.4$

Solve the inequality for y: $y - 3x < 15$

Graph the inequality on a coordinate plane: $y - 3x < 15$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve compound inequalities involving "and"

Solve compound inequalities involving "or"

Solve systems of inequalities

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Solve the inequality then graph the solution. $-13 < 2 - 5x \leq -2$

Solve the inequality then graph the solution. $2x + 3 < 1 \quad or \quad 5 - 3x > 1$

Solve the system of inequalities by graphing: $x - y < 4$ and $x + y > -3$

Misconceptions/Common Errors
Students may have the misconception that the variable must be on the left side of the equals sign and the solution on the right. This can cause confusion when problems are presented in the form $5 \leq x$. Students should work with examples where the variable is on either side of the inequality symbol.

Students generalize that the direction of the inequality determines the direction of shading on the number. For example, in $x > -3$ the inequality symbol is pointing towards the right; therefore, students shade to the right of -3 on the number line. But this generalization is not true in inequalities such as $5 \geq x$.

Students confuse solving linear inequalities **in** one variable with solving linear inequalities **for** one variable. Linear inequalities **in** one variable are graphed on the number line. Linear inequalities with two variables may be solved **for** one variable and are graphed on a coordinate plane.

Technology Notes
Students may use a graphing utility to verify for which values of x the inequality is true. For example, given the inequality $2x - 3 < 7$, students would graph $y = 2x - 3$ and $y = 7$ then determine for which values of x is the graph of $y = 2x - 3$ below the graph of $y = 7$.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure to solve linear inequalities and graph their solutions. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-4.9 Carry out a procedure to solve systems of two linear equations graphically

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
System of equation

Continuum of Knowledge
In 8th grade, students translate among verbal, graphic, tabular and algebraic representations of linear functions (8-3.1) which include generating a table of values from a given equation and graphing those values on the coordinate plane.

In Elementary Algebra, students carry out a procedure to solve systems of linear equations algebraically.

In Intermediate Algebra, students carry out a procedure to solve systems of linear inequalities algebraically (IA 2.1) and graphically (IA-2.2). Students transfer their knowledge of systems to carry out a procedure to solve systems involving one linear and one quadratic function (IA-2.11).

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Graph a linear equation

Determine the point of intersection of the graph of the two linear equations

Recognize and understand when a system has exactly one solution, infinitely many solutions or no solution

Check the solution to a linear system

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

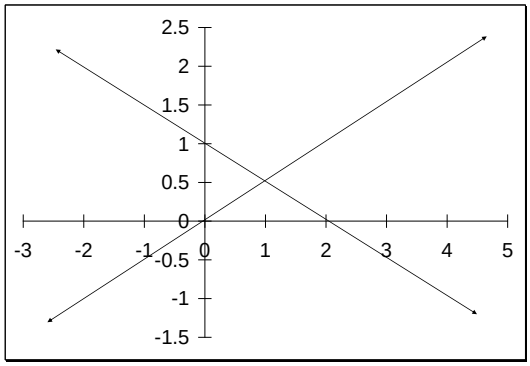
Solve by graphing. $\begin{aligned} 3x + 2y &= 4 \\ -x + 3y &= -5 \end{aligned}$

Does the system have one solution, infinitely many solutions or no solution?

$$-a-2b=5$$
$$2a+4b=10$$

Which system of linear equations is graphed below?

a. $-4x+3y=2$ $-2x+y=1$ *b.* $-x+2y=2$ $-3x+4y=2$ *c.* $2x+y=1$ $4x+3y=2$ *d.* $x+2y=2$ $x-2y=0$



Which ordered pair is a solution of the following system of linear equations?

$$m+n=3$$
$$2m+n=6$$

a. $(1,2)$ *b.* $(0,3)$ *c.* $(2,1)$ *d.* $(3,0)$

Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph a system of linear equations containing more two linear equations

Graph a system of linear equations containing more than two variables

Examples of Non-Essential Tasks

The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Solve the system.

$$3x-2y=11$$
$$-x+6y=7$$
$$x+y=7$$

Solve the system.

$$x - 2y + 3z = 7$$
$$2x + y + z = 4$$
$$-6x + 4y - 4z = -20$$

Misconceptions/Common Errors

Students may verify the solution by substituting the resulting ordered pair into an equation other than the original equation. If an error occurs in solving the system, substituting the ordered pair in the incorrect form will yield incorrect result. The solution should be verified using the original equations.

Technology Notes

Students may check their solutions by direct substitution into the system.

Students may check their solutions by using the intersect feature on a graphing utility in order to determine where the graphs of the two linear functions intersect.

The table of values can also be used to verify for which x value are the y values of both equations equal. The table will need to be set in order to display the appropriate values.

One of the difficulties students may have when using a graphing utility to determine the point of intersection is setting an appropriate viewing window that clearly displays the point of intersection. Students need sufficient practice performing this skill.

Assessment Guidelines

The objective of this indicator is for the student to carry out a procedure to solve systems of two linear equations graphically. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-4.10 Carry out a procedure to solve systems of two linear equations algebraically

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
System of equation
Substitution Method
Elimination Method (Linear combination)
Consistent
Dependent
Independent
Inconsistent

Continuum of Knowledge
In 8th grade, students translate among verbal, graphic, tabular and algebraic representations of linear functions (8-3.1) which include generating a table of values from a given equation and graphing those values on the coordinate plane.

In elementary algebra, students carry out a procedure to solve systems of linear equations algebraically.

In Intermediate Algebra, students carry out a procedure to solve systems of linear inequalities algebraically (IA 2.1) and graphically (IA-2.2). Students transfer their knowledge of systems in order to carry out a procedure to solve systems involving one linear and one quadratic function (IA-2.11).

Essential learning and understanding
It is essential for students to do the following for the attainment of this indicator:

Multiply a linear equation by a constant to create an equivalent linear equation

Understand and apply the principle of the additive inverse

Solve one step linear equations

Apply the substitution or elimination method to solve a system

Recognize and understand when a system has exactly one solution, infinitely many solutions or no solution

Check solutions to the system using an appropriate method

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Solve. $\begin{aligned} x &= y - 1 \\ 2x + y &= -2 \end{aligned}$

Solve. $\begin{aligned} a + 4b &= 23 \\ -a + b &= 2 \end{aligned}$

Solve. $\begin{aligned} p - 3q &= 30 \\ 3q + p &= 12 \end{aligned}$

Solve. $\begin{aligned} s &= t + 4 \\ 2t + s &= 19 \end{aligned}$

Verify whether the ordered pair, (-4, 23), is a solution to the system.

$$\begin{aligned} 2x + y &= 15 \\ -x + y &= 12 \end{aligned}$$

Does the system have one solution, no solution or infinitely many solutions? $\begin{aligned} 3x + 4y &= 8 \\ -3x - 4y &= 10 \end{aligned}$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve a linear system containing more than two linear equations.

Solve a linear system containing more than two variables.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Solve the system

$$\begin{aligned} 2a + b &= 10 \\ 5a - b &= 18 \\ -4a + b &= -14 \end{aligned}$$

Solve the system

$$x - 2y + 3z = 7$$
$$2x + y + z = 4$$
$$-6x + 4y - 4z = -20$$

Misconceptions/Common Errors
Students may eliminate a variable because their coefficients have opposite signs without making sure that the two expressions are additive inverses.

Students may verify the solution by substituting the resulting ordered pair into equation other than the original equation. If an error occurs in solving the system, substituting the ordered pair in the incorrect form will yield incorrect result. The solution should be verified using the original equations.

Technology Notes
Students can check their solutions by direct substitution or by using the intersect feature on a graphing calculator.

Assessment Guidelines
The objective of this indicator is for the student to carry out a procedure; therefore, the primary focus of the assessment should be for students to carry out such procedures.

2007 Mathematics Academic Standards Support Guide for the High School Core Area of Elementary Algebra

This section of the standards support guide addresses Elementary Algebra Standard EA-5 and provides additional information about its indicators EA-5.1 thorough EA-5.12.

Standard EA-5: The student will demonstrate through the mathematical processes an understanding of the graphs and characteristics of linear equations and inequalities.

Indicators

EA-5.1 Carry out a procedure to graph a line when given the equation of the line.

EA-5.2 Analyze the effects of changes in the slope, m, and the y-intercept, b, on the graph of $y = mx + b$.

EA-5.3 Carry out a procedure to graph the line with a given slope and a y-intercept.

EA-5.4 Carry out a procedure to graph the line with a given slope passing through a given point.

EA-5.5 Carry out a procedure to determine the x-intercept and y-intercept of lines from data given tabularly, graphically, symbolically, and verbally.

EA-5.6 Carry out a procedure to determine the slope of a line from data given tabularly, graphically, symbolically, and verbally.

EA-5.7 Apply the concept of slope as a rate of change to solve problems.

EA-5.8 Analyze the equations of two lines to determine whether the lines are perpendicular or parallel.

EA-5.9 Analyze given information to write a linear function that models a given problem situation.

EA-5.10 Analyze given information to determine the domain and range of a linear function in a problem situation.

EA-5.11 Analyze given information to write a system of linear equations that models a give problem situation.

EA-5.12 Analyze given information to write a linear inequality in one variable that models a given problem situation.

EA-5.1 Carry out a procedure to graph a line when given the equation of the line**.**

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
coordinate plane
x-axis
y-axis
quadrant
coordinate(s)
intercept(s)

Continuum of Knowledge
In 6th grade, students locate ordered pairs on a coordinate grid (6-4.1). In 7th grade, students understand slope as a constant rate of change (7-3.2) and use inverse operations to solve equations (7-3.3). In Grade 8, students translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1) and classify relationships between two variables in graphs, tables, and/or equations as either linear or nonlinear (8-3.5).

In Elementary Algebra, students graph a line when given the equation of the line**.**

Students use this skill when graphically solving simultaneous equations or systems of linear inequalities in Intermediate Algebra (IA-2.2).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Understand how to graph a line from an equation given in any form.

Determine the slope and y-intercept of a line, given its equation (any form).

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Graph the equation $y = 4 - \frac{2}{3}x$

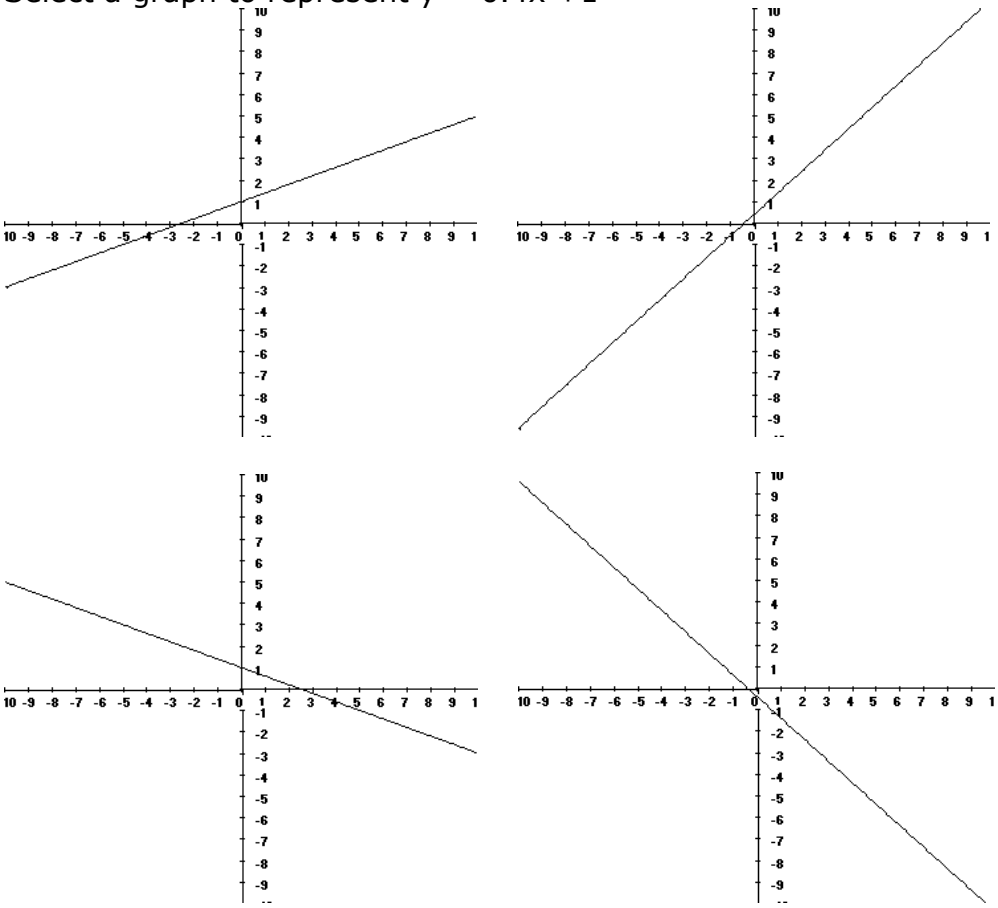
Graph the equation $5x + y = 7$

Graph the equation $2x + 5y - 11 = 0$

Graph the function f(x) = 2

Graph the function f(x) = 2x – 4

Select a graph to represent y = 0.4x +1



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph lines whose equations include irrational numbers.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Sketch the graph of 3x + 2y + 4z = 12

Sketch the graph of $2 = \sqrt{5}\,x + \sqrt{2}\,y$

Misconceptions/Common Errors
Students may confuse the slope with the y-intercept.

Students may confuse the x-axis with the y-axis (or the x-intercept with the y-intercept.

Students may invert the slope, using the change in x as the numerator and the change in y as the denominator of the slope.

Students may assume that the scale of the graph is always one unit.

Technology Note
Students may use technology for complex computation.

Students may use technology for graphing but must be able to transfer the graph to paper.

Students may use technology to verify graphs produced by hand. Students should be aware that the scale of a graphing utility may make the line appear to be more or less steep than the graph produced by hand.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to graph a line given its equation. Therefore, the primary focus of the assessment should be for students to carry out such procedures. For this indicator, assessment items should be written that encourage students to generate a table of values for x and y.

EA-5.2 Analyze the effects of changes in the slope, *m,* and the *y*-intercept, *b,* on the graph of $y = mx + b$.

Taxonomy Level
4.1-B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
slope
y-intercept
slope-intercept form

Continuum of Knowledge
In 7th grade students understand slope as a constant rate of change (7-3.2). In 8th grade, students use intercepts to locate lines in a coordinate plane (8-4.2) and translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1).

In Elementary Algebra, students analyze the effects of changes in the slope and the *y*-intercept on the graph of a line.

In Intermediate Algebra, students carry out a procedure to graph transformations of parent functions other than linear functions (including $y = x$, $y = x^2$, and $y = |x|$) (IA-2.8).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Determine the slope and y-intercept of a line, given its equation in slope-intercept form.

Understand how the value of the slope affects the steepness of the line.

Understand how the value of the y-intercept affects where the line crosses the y-axis.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> What will happen to the graph of y = 2x + 5 if the value of the y-intercept decreases by two units?
>
> What will happen to the graph of y = 2x + 5 if the value of the slope increases by two units?

Graph y = 2x + b, where b = {-2, -1, 0, 1, 2}. Write a sentence to summarize the effect of a change in b on the graph of the linear equation.

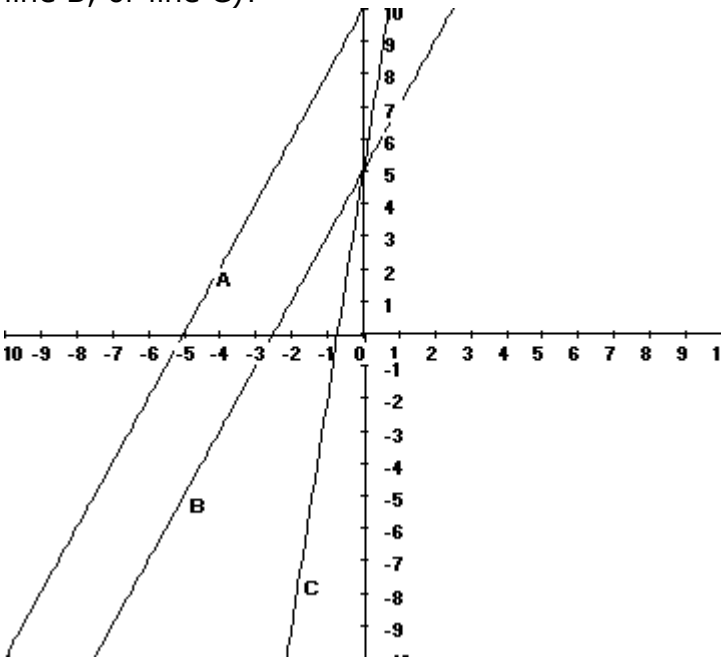
How do the graphs of $y = x + 3$ and $y = x + 5$ differ?

How does changing the constant c in $y = x + c$ affect the graph?

What does decreasing the constant c by 2 units in an equation of the form $y = x + c$ do to its graph?

Study the graphs of $y = x + c$ for c = 1, c = 2, c = 3, c = -1 and c = -2. Write a sentence describing how changing the constant c in $y = x + c$ affects the graph.

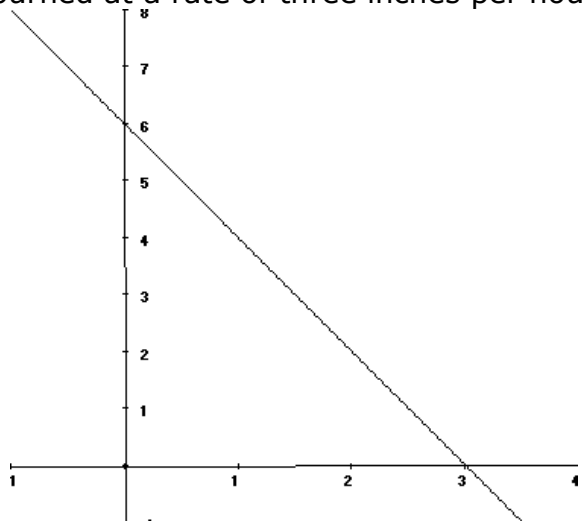
If the slope of the line whose equation is y = 2x + 5 is increased by 5 units, which of the following is the graph of the new equation (line A, line B, or line C)?



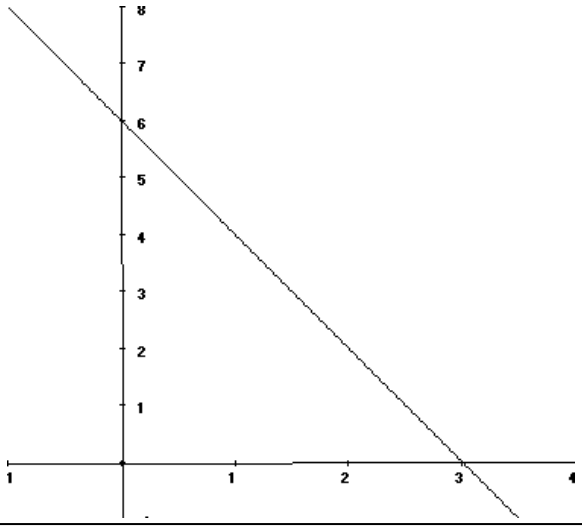
Write a sentence to compare the graphs of y = 2x + 3 and y = 4x + 3. *(Possible answer: Both lines pass through (0. 3) but y = 2x + 3 is not as steep as y = 4x + 3)*

Describe the change that would occur if y = 2x + 4 is changed to y = 2x – 4. *(Possible answer: The lines would be parallel but y = 2x + 4 would have a y-intercept of positive 4 and y = 2x – 4 would have a y-intercept of negative 4.)*

Below is a graph of the height of a six inch candle that burns at a rate of two inches per hour. How would the graph change if the candle burned at a rate of three inches per hour?



Below is a graph of the height of a six inch candle that burns at a rate of two inches per hour. How would the graph change if the candle were 10 inches tall?



Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Analyze the effects of changes in the slope, m, and the y-intercept, b, where m is an irrational number.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Sketch the graph of $-1.552x - 2.233y = \pi$

Sketch the graph of $y = \sqrt{5}x + 4$

Misconceptions/Common Errors
Students may confuse the slope with the y-intercept.

Technology Note
This topic may be introduced by having the students explore the graphs of parallel lines having a variety of y-intercepts or the graphs of lines with the same y-intercept and a variety of slopes to discover patterns in the changes of the graphs.

Students may use technology when discovering the transformational patterns that occur when the slope and/or y-intercept are changed.

Assessment Guidelines
The objective of this indicator is to analyze an equation to discover how the equation relates to the graph of the equation. Students should also be able to analyze a graph to select an appropriate equation. Therefore, the primary focus of the assessment should be for students to analyze the graph or the equation in order to connect the graph with the equation.

EA-5.3 Carry out a procedure to graph the line with a given slope and a *y*-intercept**.**

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
slope
y-intercept
slope-intercept form
scale

Continuum of Knowledge
In 7th grade students understand slope as a constant rate of change (7-3.2). In 8th grade, students use intercepts to locate lines in a coordinate plane (8-4.2) and translate among verbal, graphic, tabular, and algebraic representations of linear functions (8-3.1).

In Elementary Algebra, students graph the line with a given slope and a *y*-intercept.

In Intermediate Algebra, students carry out a procedure to graph translations and transformations of parent functions (IA-2.7 and IA-2.8).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Determine the slope and y-intercept of a line from the slope-intercept form of the equation.

Plot on a coordinate plane the y-intercept of a line.

Use slope and the y-intercept to locate on a coordinate plane a second point on a line.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Graph a line with a slope of -3 and a y-intercept of 7.

Graph the equation $y = \frac{4}{3}x + 5$

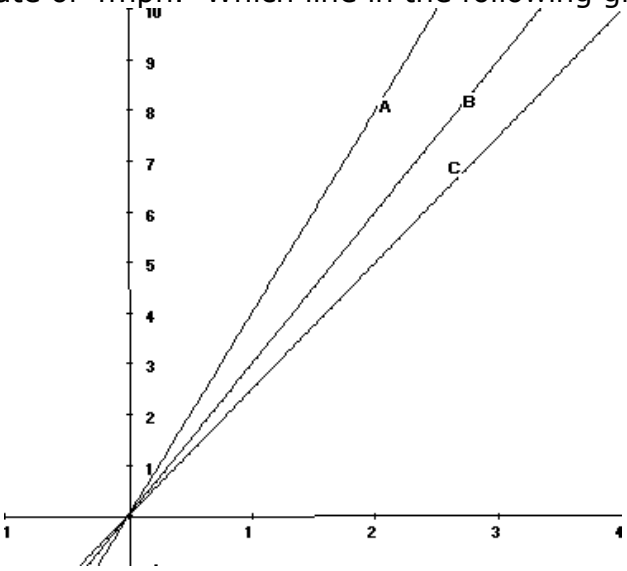
Graph $y - 4x = 12$

Graph $y = 6x + 0.75$

Graph $4x + 5y = 15$

Graph the equation $2x + 2y - 4 = x + 5$.

Tom runs at a rate of 2.5 mph. Sue runs at a rate of 3 mph and Fred runs at a rate of 4mph. Which line in the following graph represents Sue's run?



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph a line with a slope that is an irrational number.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Graph the line with slope $\pi/2$ and y-intercept 4.

Misconceptions/Common Errors
Students may confuse the slope and the y-intercept.

Students may assume that the scales of the x and y axes are always single units.

Technology Note
Students may use technology for graphing but must be able to transfer the graph to paper.

Students may need instruction and practice in selecting appropriate windows and scales when creating graphs of linear equations and linear functions using a graphing utility.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to graph the line with a given slope and a *y*-intercept**.** Therefore, the primary focus of the assessment should be for students to carry out such procedures. In addition, teachers may write assessment items that ask students to select a graph that is appropriate for an equation or an equation that is appropriate for a graph.

EA-5.4 Carry out a procedure to graph the line with a given slope passing through a given point**.**

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
slope
point-slope form

Continuum of Knowledge
In grade six, students represent with ordered pairs of integers the location of points in a coordinate grid. (6-4.1) In 7th grade students understand slope as a constant rate of change (7-3.2).

In Elementary Algebra, students graph the line with a given slope passing through a given point**.**

In Intermediate Algebra, students carry out a procedure to graph translations and transformations of parent functions (IA-2.7 and IA-2.8).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Understand the Cartesian coordinate plane system.

Understand that a unique line is determined by two points

After graphing a given point, use the slope to determine a second point.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> Select the graph that represents an equation with a slope of 3 and passing through the point (-4, 7).
>
> Graph a line that passes through (3.25, -3) and has a slope of 5.
>
> Graph a line that is parallel to y=3x -7 and that passes through the point (1, 2).
>
> Graph a line that is perpendicular to y=3x -7 and that passes through the point (1, 2).

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph piecewise functions.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

$$\text{Graph this function: } f(x) = \begin{cases} -1 \text{ if } x < 0 \\ 1 \text{ if } 0 \geq x \geq 2 \\ 3 \text{ if } x > 2 \end{cases}$$

Misconceptions/Common Errors
Students may invert the slope, using the change in x as the numerator and the change in y as the denominator of the slope.

Students may assume that the scale of the graph is always one unit.

Technology Note
Students may use technology to verify answers after they have placed the equation in function form.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to graph the line with a given slope passing through a given point. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-5.5 Carry out a procedure to determine the *x*-intercept and *y*-intercept of lines from data given tabularly, graphically, symbolically, and verbally**.**

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
x-intercept
y-intercept
x-axis
y-axis

Continuum of Knowledge
In grade six, students represent with ordered pairs of integers the location of points in a coordinate grid. (6-4.1) In Grade 8, students translate among verbal, graphic, tabular, and algebraic representations of linear functions. (8-3.1)

In Elementary Algebra, students determine the *x*-intercept and *y*-intercept of lines from data given in tables, in graphs, using symbols and using words. Student understanding should exceed rote operational proficiency.

In Intermediate Algebra, students carry out a procedure to determine specified points (including zeros) of polynomial functions. (IA-4.2)

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Recognize the x and y-intercepts form a table of values.

Recognize the x and y-intercepts as the points where a line intersects each axis.

Substitute a value of zero for x in a linear equation to find the y-intercept.

Substitute a value of zero for y in a linear equation to find the x-intercept.

Translate from linear verbal models to algebraic models.

Recognize that vertical lines may have no y-intercept and that horizontal lines may have no x-intercept.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

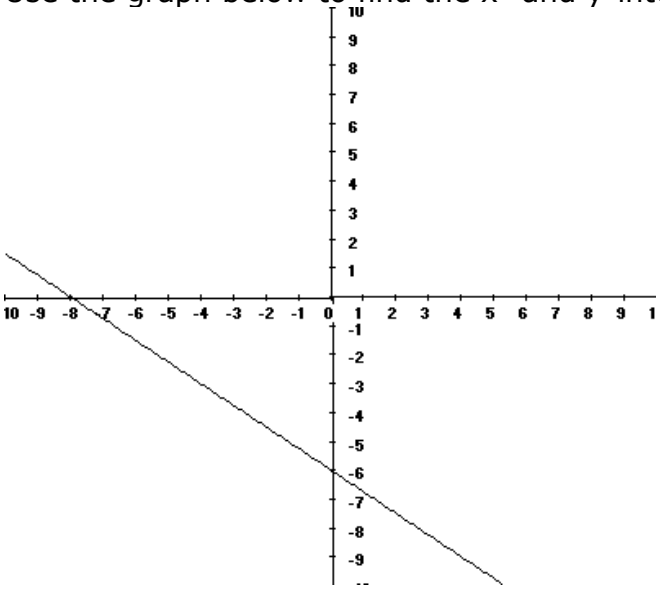
The table of values below lists points on a line. What is the y-intercept of the line?

X	-1	0	1	2
Y	6	3	0	-3

Select the equation that has an x-intercept of -4 and a y-intercept of 2.

a) $y = -\frac{1}{2}x - 4$
b) $y = 2x - 4$
c) $y = -\frac{1}{2}x + 2$
d) $-4x + 2y = 0$

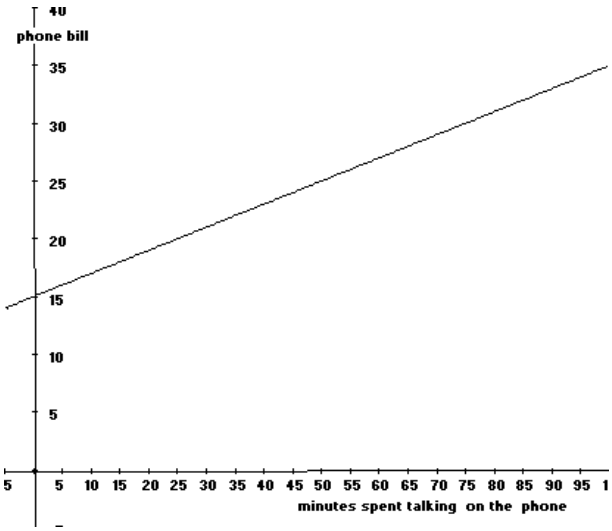
Use the graph below to find the x- and y-intercepts.



What is the x-intercept of the graph of $y= 2x +6$?

What is the y-intercept of the graph of $4y - 2x = 6$?

A cell phone provider charges a flat fee of $15 plus $.10 per minute each month. Below is the graph of a function modeling the cost of the cell phone as a function of the number of minutes used. What is the y-intercept and what is represented by the y-intercept?



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Determine the intercepts of piece-wise functions.

Determine the intercepts of non-linear functions.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Find the y-intercept of $y = |x+2|$

What is the x-intercept of $y = x^3$?

Misconceptions/Common Errors
Students may mistakenly substitute 0 for x to find the x-intercept (or 0 for y to find the y-intercept).

Students may be confused when the graph of a line goes through the origin.

Technology Note
Use technology where appropriate**.**

Assessment Guidelines
The objective of this indicator is to carry out a procedure to determine the *x*-intercept and *y*-intercept of lines from data given tabularly, graphically, symbolically, and verbally. Therefore the primary focus of the assessment should be for students to carry out such procedures.

EA-5.6 Carry out a procedure to determine the slope of a line from data given tabularly, graphically, symbolically, and verbally**.**

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Evaluation
Simplification
Substitution

Continuum of Knowledge
In 7th grade students understand slope as a constant rate of change (7-3.3). In Grade 8, students identify the slope of a linear equation from a graph, equation, and/or table (8-3.7).

In Elementary Algebra, students carry out a procedure to determine the slope of a line from data given tabularly, graphically, symbolically, and verbally.

In Pre-calculus, students carry out a procedure to compute the slope of a line when given the angle of inclination of the line (PC-5.15).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Given at table containing solutions to a linear equation, use two of those values to calculate the rise and run of the line and divide the rise by the run to calculate the slope.

Given a graph of a line, identify two points on the line, identify the x and y coordinates of those points, use those values to calculate the rise and run of the line and divide the rise by the run to calculate the slope.

Given any form of an equation of a line, rewrite the equation in slope intercept form and identify the slope of the line.

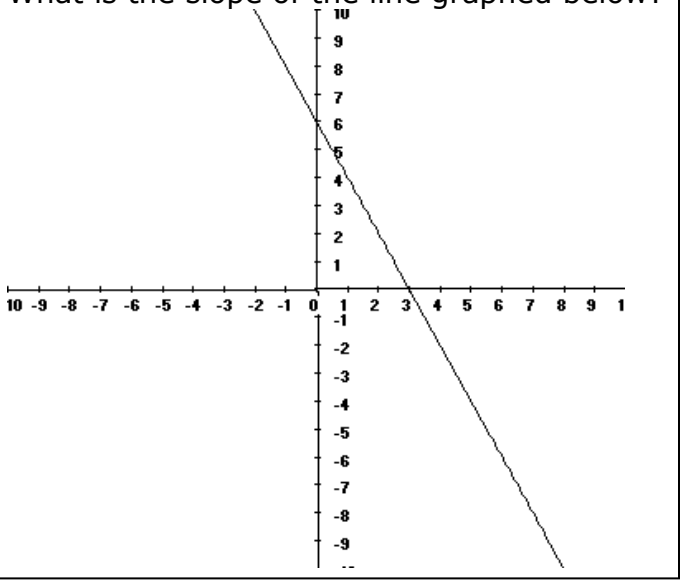
Given a verbal description of a constant rate of change between two variables, recognize this as the slope of a linear relationship.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

The table below contains some values of a linear equation. What is the slope of the line?

X	-2	-1	0
Y	-8	-5	-2

What is the slope of the line graphed below?



What is the slope of the line with the equation 3x + 2y = 7?

What is the slope of the function f(x) = -x + 4?

The slope of a roof describes the steepness of a roof. If a roof rises 9 feet for every 15 feet of run, what is the slope of the roof?

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Find the slope of a line whose coordinates involve irrational numbers.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Find the slope of the line with an equation $\sqrt{5}$x+4y = 7.

Misconceptions/Common Errors
Students may confuse the slope with the y-intercept.

Students may confuse the x-axis with the y-axis (or the x-intercept with the y-intercept.

Students may invert the slope, using the change in x as the numerator and the change in y as the denominator of the slope.

Students may assume that the scale of the graph is always one unit.

Technology Note
Students may use technology to check computations.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to determine the slope of a line from data given tabularly, graphically, symbolically, and verbally. Therefore, the primary focus of the assessment should be for students to carry out such procedures.

EA-5.7 Apply the concept of slope as a rate of change to solve problems**.**

Taxonomy Level
3.2-B
Cognitive Process Dimension: Apply
Knowledge Dimension: Conceptual Knowledge

Key Concepts
slope
rise
run
ratio
rate of change

Continuum of Knowledge
In 7th grade students understand slope as a constant rate of change (7-3.3). In Grade 8, students identify the slope of a linear equation from a graph, equation, and/or table (8-3.7).

In Elementary Algebra students apply the concept of slope as a rate of change to solve problems.

In Pre-calculus students carry out a procedure to compute the slope of a line when given the angle of inclination of the line (PC-5.15).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Recognize the slope of a line in a given linear relationship.

Interpret the slope of a line in a given linear relationship as a rate of change between two variables.

Use the slope to find the change in one variable for a given change in the other variable in a linear relationship.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

In the equation y = 4x, if the value of x is increased by two, what is the effect on the value of y?
a) It is increased by eight
b) It is increased by six
c) It is increased by 2

d) It is sixteen times the original amount
e) It is eight times the original amount
(NAEP released item)

Yvonne has studied the cost of tickets over time for her favorite sports team. She has created a model to predict the cost of a ticket in the future. Let *C* represent the cost of a ticket in dollars and *y* represent the number of years in the future. Her model is as follows.

$$C = 2.50y + 13$$

Based on this model, how much will the cost of a ticket increase in two years?

a) $5 b) $8 c) $13 d) $18 e) $26
(NAEP released item)

Carla has a lemonade stand. Her profit is modeled by y = 0.75x – 9.85 where y is profit and x is the number of cups of lemonade sold. If she sells five more cups of lemonade today than she sold yesterday, how much more money does she make today?

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Evaluate the value of the variables. The problem should focus on the rate of change.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Carla has a lemonade stand. Her profit is modeled by y = 0.75x – 9.85 where y is profit and x is glasses of lemonade sold. If she sells five glasses of lemonade, what is her profit?

Misconceptions/Common Errors

Students may not understand rates (speed, growth, gas mileage) as slopes.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to apply the concept of slope as a rate of change to solve problems. Therefore, the primary focus of the assessment should be for students to apply this concept.

EA-5.8 Analyze the equations of two lines to determine whether the lines are perpendicular or parallel.

Taxonomy Level
4.1-B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Slope
Parallel lines
Perpendicular lines

Continuum of Knowledge
In 7th grade students analyze the congruent and supplementary relationships—specifically, alternate interior, alternate exterior, corresponding, and adjacent—of the angles formed by parallel lines and a transversal (7-4.5).

In Elementary Algebra students analyze the equations of two lines to determine whether the lines are perpendicular or parallel.

In Geometry students apply properties of parallel lines, intersecting lines, and parallel lines cut by a transversal to solve problems (G-2.2). Also, students carry out a procedure to create geometric constructions (including the midpoint of a line segment, the angle bisector, the perpendicular bisector of a line segment, the line through a given point that is parallel to a given line, and the line through a given point that is perpendicular to a given line) (G-2.5).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Know the relationship between the slopes of two parallel lines.

Know the relationship between the slopes of two perpendicular lines.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Are the two lines $y = 3x - 5$ and $y = 3x + 5$ parallel?

Are the two lines $y = 3x - 5$ and $y = -3x + 5$ perpendicular?

Classify the two lines as parallel, perpendicular or neither: y = 3x – 5 and y = -3x – 5

Classify the two lines as parallel, perpendicular or neither: y = 3x – 5 and y = 3x + 5

Classify the two lines as parallel, perpendicular or neither: y = 3x – 5 and y = $-\frac{1}{3}$x – 5

Which of the lines whose equations are given below is perpendicular to y = 3x – 2?

a) y = 3x + 5 b) y = -3x + 5 c) y = $\frac{1}{3}$x – 5

d) y = $-\frac{1}{3}$x – 5 e) none of these

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Find the equation of a parallel or perpendicular line to a given line.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Write the equation of a line that is parallel to y = 3x - 2.

Write the equation of a line that is perpendicular to y = 3x - 2

Misconceptions/Common Errors
Students often choose negative or the reciprocal slope instead of the negative reciprocal slope when identifying perpendicular lines.

Students often mistake slope for y-intercept if the equation is written in Y = b + mx form.

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to analyze given equations to determine if two lines are parallel or perpendicular.

Assessment should focus on using the equations to determine whether the two given lines are parallel

EA-5.9 Analyze given information to write a linear function that models a given problem situation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Linear function
Modeling

Continuum of Knowledge
In eighth grade, students generate and solve complex abstract problems that involve modeling physical, social, or mathematical phenomena (8-1.1).

In Elementary Algebra students will write a system of linear equations that models a given problem situation.

In Intermediate Algebra, students analyze a problem situation to determine a system of linear inequalities that models the problem situation (IA-2.3)

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Assign variables to quantities for a given problem situation.

Recognize relationships between variables representing quantities in a given problem situation.

Write a linear equation given a linear relationship between two variables.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> Todd makes $6.00 per hour working at a convenience store. He will get a bonus of $25 this week. Write a linear function the represents the amount he makes this week as a function of hours he works.
>
> Carla has a lemonade stand. She spends $8.75 on materials and ingredients. She charges $0.75 for each glass of lemonade. Write a linear function that expresses her profit as a function of glasses sold.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Evaluate the function for a particular value of x.

Solve the function for a particular value of y

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> Todd makes $6.00 per hour working at a convenience store. He will get a bonus of $25 this week. How many hours must he work to make $250?
>
> Carla has a lemonade stand. She spends $8.75 on materials and ingredients. She charges $0.75 for each glass of lemonade. How many glasses does she have to sell to make her money back?

Misconceptions/Common Errors
None Noted

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to analyze given information to write linear equation to model a situation.
Assessment should focus on writing a linear equation that models the problem situation.

EA-5.10 Analyze given information to determine the domain and range of a linear function in a problem situation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Domain of a function
Range of a function
Continuous
Discrete
Modeling

Continuum of Knowledge
In seventh grade, students generate and solve complex abstract problems that involve modeling physical, social, or mathematical phenomena (7.11). In eighth grade, students identify the coordinates of the *x*- and *y*-intercepts of a linear equation from a graph, equation, and/or table (8-3.6).

In Elementary Algebra students will find the domain and range of linear functions in a problem situation.

In Intermediate Algebra, students will carry out a procedure to determine the domain and range of discontinuous functions (including piecewise and step functions) (IA-2.10).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Interpret linear functions that model a problem situation.

Find the set of x-coordinates that determines the domain of a linear function.

Determine the meaningful domain of a linear function for a given problem situation.

Some problems may require finding the zeros of the function to determine the reasonable domain.

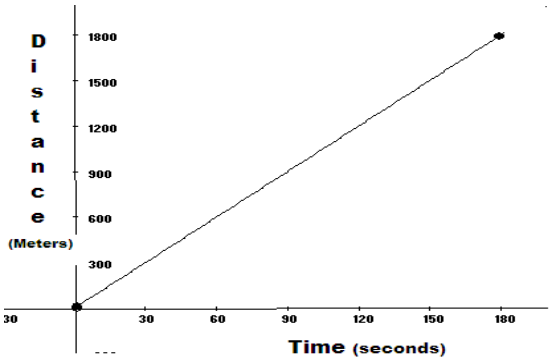
Specify between discrete and continuous domains.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Tony has a gross of pencils (144 pencils). He sells them for $ 0.10 each. This situation is modeled by y = 0.10x where y is the amount of money he takes in and x is the number of pencils he sells. What is the domain of this function in the context of this situation?
Answer
Domain: {0,1,2,3,4,…,144}

Carla has a lemonade stand. She can sell at most 50 cups of lemonade in a day. Her daily profit is modeled by P(c) = 0.75c – 9.75. Where profit, P, is a function of cups, c. What is the reasonable domain for the function in the context of this problem?

The graph below represents the distance traveled by a bicycle traveling at a constant speed of 10 meters/second for 180 seconds. What is the domain of the function?



Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Generate the modeling function from a verbal description of the problem.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Carla has a lemonade stand. She can sell at most 50 glasses of lemonade in an afternoon. Find an equation that models her daily profit and state the domain.

Misconceptions/Common Errors
Students confuse domain and range. Students confuse continuous and discrete.

Technology Note
Students may use technology (graph or table) to find or estimate zeros.

Assessment Guidelines
The objective of this indicator is to analyze given information to determine the domain and range of a linear function in a problem situation. Assessment should focus on determining the domain and range from the constraints of the problem situation.

EA-5.11 Analyze given information to write a system of linear equations that models a given problem situation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
System of linear equations
Modeling

Continuum of Knowledge
In eighth grade, students generate and solve complex abstract problems that involve modeling physical, social, or mathematical phenomena (8-1.1).

In Elementary Algebra students will write a system of linear equations that models a given problem situation.

In Intermediate Algebra, students analyze a problem situation to determine a system of linear inequalities that models the problem situation (IA-2.3)

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Assign variables to quantities for a given problem situation.

Express relationships between variables representing quantities in a given problem situation.

Write a system of linear equations given two linear relationships between two variables.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> I have thirteen coins consisting of quarters and dimes. The sum of money I have is $2.20. Write a system of equations that could be solved to determine how many of each coin that I have.
>
> You are considering a membership in two health clubs. One has a $200 down payment and monthly payments of $15. The other has a $30 down payment and monthly payments of $50 dollars. Write a system of equations that could be solved to determine how many months you have to be a member before plan one becomes a better deal?

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve the system of equations

Set up equations that are not 2 x 2 linear systems.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> I have thirteen coins consisting of quarters and dimes. The sum of money I have is $2.20. How many quarters do I have? (The question makes this problem nonessential for this indicator because it involves solving the system rather than setting up the system from the given information.)
>
> I have eight coins consisting of quarters, dimes and nickels. The sum of money I have is $1. I have twice as many dimes as nickels. Write a system of equations that could be solved to determine how many of each coin I have.

Misconceptions/Common Errors
None Noted

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to analyze given information to write an appropriate system of equations to model a situation.
Assessment should focus on writing a system of linear equations that models the problem situation.

EA-5.12 Analyze given information to write a linear inequality in one variable that models a given problem situation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Linear inequality
Modeling

Continuum of Knowledge
In eighth grade, students generate and solve complex abstract problems that involve modeling physical, social, or mathematical phenomena (8-1.1).

In Elementary Algebra students will write a linear inequality in one variable that models a given problem situation.

In Intermediate Algebra, students analyze a problem situation to determine a system of linear inequalities that models the problem situation (IA-2.3)

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Assign a variable to the quantity of interest for a given problem situation.

Determine the restrictions on a variable of interest in a given problem situation from given information.

Write a linear inequality in one variable given restrictions on the variable.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> Write an inequality in one variable to represent the set of numbers that satisfy this statement: Three times a number plus one is less than five.
>
> Todd wants to make at least $250 this week working at a convenience store. Todd makes $6.00 per hour and will earn a $25 bonus this week. Write a linear inequality in one variable that models the problem situation.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Solve the linear inequality.

Write a linear inequality involving two variables.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> Todd wants to make at least $250 this week working at a convenience store. Todd makes $6.00 per hour and will earn a $25 bonus this week. What is the minimum number of hours that Todd must work? (The question makes this problem nonessential for this indicator because it involves solving the inequality rather than writing the inequality.)
>
> Write an inequality that models this situation: I have some quarters and some dimes in an envelope that total less than $2.50.

Misconceptions/Common Errors
None Noted

Technology Note
Use technology where appropriate.

Assessment Guidelines
The objective of this indicator is to analyze given information to write an appropriate inequality to model a situation.
Assessment should focus on writing an inequality that models the given problem situation.

2007 Mathematics Academic Standards Support Guide for the High School Core Area of Elementary Algebra

This section of the standards support guide addresses Elementary Algebra Standard EA-6 and provides additional information about its indicators EA-6.1 thorough EA-6.6.

Standard EA-6: The student will demonstrate through the mathematical processes an understanding of quadratic relationships and functions.

Indicators

EA-6.1 Analyze the effects of changing the leading coefficient *a* on the graph of $y = ax^2$.

EA-6.2 Analyze the effects of changing the constant *c* on the graph of $y = x^2 + c$.

EA-6.3 Analyze the graph of a quadratic function to determine its equation.

EA-6.4 Carry out a procedure to solve quadratic equations by factoring.

EA-6.5 Carry out a graphic procedure to approximate the solutions of quadratic equations.

EA-6.6 Analyze given information to determine the domain of a quadratic function in a problem situation.

EA-6.1 Analyze the effects of changing the leading coefficient a on the graph of $y = ax^2$

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Leading coefficient
Transformation
The graph of a function
The stretch of a graph
The shrink of a graph

Continuum of Knowledge
In eighth grade students translated between graphic and algebraic representations of linear functions (8-3.1) and identified the y-intercepts of linear equations from the graph (8-3.6)

In Elementary Algebra students investigate graphs of equations of the form $y = ax^2$ for different values of a in order to determine the result of a change in the leading coefficient on the graph of the equation.

In Intermediate Algebra, students graph transformations of parent functions (IA-2.8), Match the equation of a conic section with its graph (IA-5.7), and carry out a procedure to write an equation of a quadratic function when given its roots (IA-3.6).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Interpret graphs including understanding how a graph is generated from a symbolic representation.

Recognize the leading coefficient in $y = ax^2$**.**

Determine the graphical effect of changing the sign of the leading coefficient in $y = ax^2$.

Determine the graphical effect of increasing the magnitude of the coefficient in $y = ax^2$.

Determine the graphical effect of decreasing the magnitude of the coefficient in $y = ax^2$.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

How do the graphs of $y = x^2$ and $y = -x^2$ differ?

How do the graphs of $y = 3x^2$ and $y = -3x^2$ differ?

How do the graphs of $y = ax^2$ and $y = -ax^2$ differ?

How do the graphs of $y = x^2$ and $y = 2x^2$ differ?

How do the graphs of $y = x^2$ and $y = \frac{1}{2}x^2$ differ?

How does changing the leading coefficient in $y = ax^2$ affect the graph?

What does halving the leading coefficient in an equation of the form $y = ax^2$ do to its graph?

Study the graphs of $y = ax^2$ for *a* = 1, *a* = -1, *a* = 2, *a* = -2, *a* = 0.5 and a = -0.5. Write a sentence describing how the sign of the leading coefficient affects the graph.

Study the graphs of $y = ax^2$ for *a* = 1, *a* = 2, *a* = 3, *a* = 0.5 and a = 1/3. Write a sentence describing how the relative magnitude of the leading coefficient affects the graph.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph a large number of functions by hand.

Identify the components (e.g. vertex, directrix, focal point) of a quadratic graph.

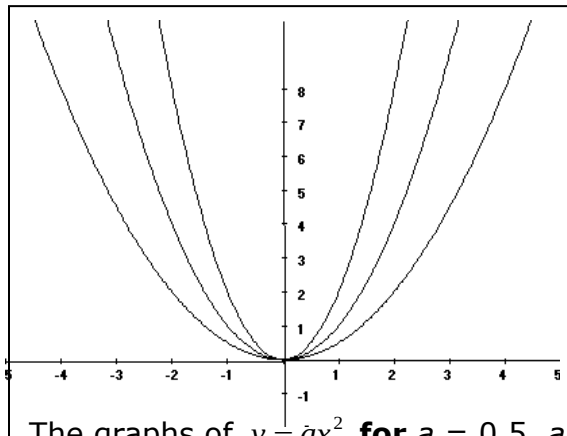
Analyze functions with irrational or imaginary coefficients.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

> On graph paper, graph $y = ax^2$ for *a* = 1, *a* = 2, *a* = 3, *a* = 0.5 and *a* = 1/3. Be sure to label the vertex, the line of symmetry, the y-intercept and any zeros. Write a sentence describing how the relative magnitude of the leading coefficient affects the graph.
>
> How do the graphs $y = \frac{5\Pi}{6}x^2$ and $y = ex^2$ differ?

Misconceptions/Common Errors
For $y = ax^2$, students assume the sign of the leading coefficient *a* is constant.

Technology Note
Students may use technology to graph multiple equations on the same set of axes for comparison. By examining differences among graphs on the same axes, students may more readily see the relationships between the equation and its graph.



The graphs of $y = ax^2$ **for** *a* = 0.5, *a* = 1 and *a* = 2

Assessment Guidelines
The objective of this indicator is to <u>analyze</u> the effects of changing the leading coefficient a on the graph of $y = ax^2$**.** The primary focus of the assessment should be for students to determine how changes in leading coefficients of equations of this form result in differences among their graphs.

EA-6.2 Analyze the effects of changing the constant c on the graph of $y = x^2 + c$

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Constant
Graph of a function
Vertical shift of a graph

Continuum of Knowledge
In eighth grade students translated between graphic and algebraic representations of linear functions (8-3.1), and identified the y-intercepts of linear equations from the graph (8-3.6).

In Elementary Algebra students will investigate graphs of equations of the form $y = x^2 + c$ for different values of c in order to determine the result of a change in the constant in the equation.

In Intermediate Algebra, students graph transformations of parent functions IA-2.7, match the equations of a conic section with their graphs (IA-5.7), and carry out a procedure to write an equation of a quadratic function when given its roots (IA-3.6).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Interpret graphs including understanding how a graph is generated from a symbolic representation.

Recognize the constant in $y = x^2 + c$ **.**

Determine the graphical effect of increasing the constant in $y = x^2 + c$.

Determine the graphical effect of decreasing the constant in $y = x^2 + c$.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

How do the graphs of $y = x^2 + 3$ and $y = x^2 + 5$ differ?

How does changing the constant c in $y = x^2 + c$ affect the graph?

What does decreasing the constant c by 2 units in an equation of the form $y = x^2 + c$ do to its graph?

Study the graphs of $y = x^2 + c$ for c = 1, c = 2, c = 3, c = -1 and c = -2. Write a sentence describing how changing the constant c in $y = x^2 + c$ affects the graph.

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Graph a large number of functions by hand.

Identify the components (e.g., vertex, directrix, focal point) of a quadratic graph.

Analyze functions with irrational or imaginary coefficients.

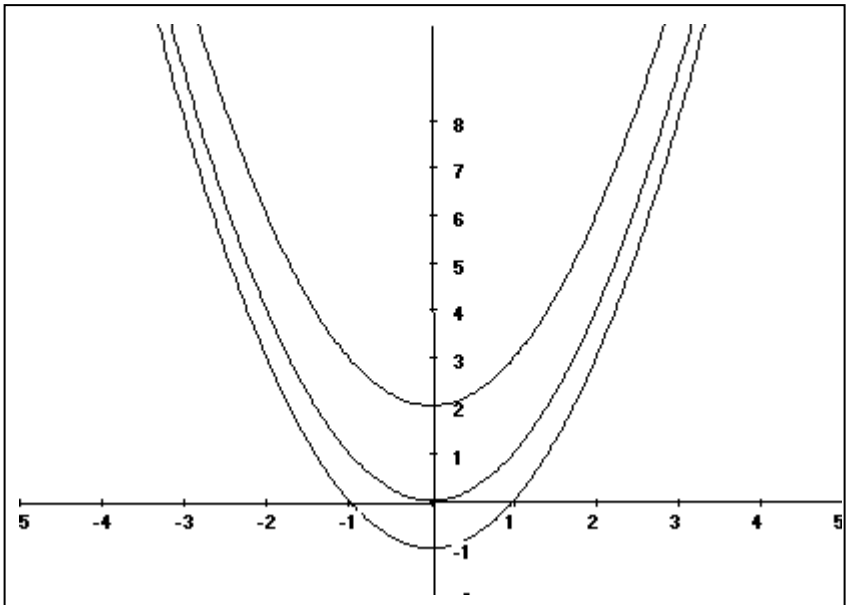
Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

On graph paper, graph $y = x^2 + c$ for c = 1, c = 2, a = 3, c = 0.5 and c = 1/3. Be sure to label the vertex, the line of symmetry, the y-intercept and any zeros. Write a sentence describing how changing the constant c affects the graph

How do the graphs $y = x^2 + \frac{\Pi}{3}$ and $y = x^2 + \frac{22}{21}$ differ?

Misconceptions/Common Errors
For $y = x^2 + c$, students assume the sign of the constant c is positive.

Technology Note
Students may use technology to graph multiple equations on the same set of axes for comparison. By examining differences among graphs on the same axes, students may more readily see the relationships between the equation and its graph.



The graphs of $y = x^2 + c$ for $c = 0$, $c = -1$ and $c = 2$

Assessment Guidelines
The objective of this indicator is to <u>analyze</u> the effects of changing the constant term c on the graph of $y = x^2 + c$**.** The primary focus of the assessment should be for students to determine how changes in the constant term of equations of this form result on differences among their graphs

EA-6.3 Analyze the graph of a quadratic equation to determine its equation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Intercepts
Vertex
Zeros
Leading Coefficient
Constant term
The graph of a function
The stretch of a graph
The shrink of a graph
The shift of a graph
The relationship between the factored form a quadratic function and its zeros

Continuum of Knowledge
In eighth grade students translated between graphic and algebraic representations of linear functions (8-3.1), and identified the y-intercepts of linear equations from the graph (8-3.6).

In Elementary Algebra students will analyze the leading coefficient, constant and possibly the zeros of the graph of a quadratic function to determine its equation.

In Intermediate Algebra, students graph transformations of parent functions IA-2.7, match the equations of a conic section with their graphs (IA-5.7), and carry out a procedure to write an equation of a quadratic function when given its roots (IA-3.6).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Associate the features of the graph with the leading coefficient or constant term of equations of the form $y = ax^2$ and $y = x^2 + c$ **.**

Associate the x-intercepts of the graph with the factored form of the equation.

Interpret graphs including understanding how a graph is generated from a symbolic representation.

Determine the graphical effect of changing the sign of the leading coefficient in $y = ax^2$.

Determine the graphical effect of increasing the constant in $y = x^2 + c$.

Determine the graphical effect of decreasing the constant in $y = x^2 + c$.

Associate the x-intercepts of the graph of a quadratic function to its factored form.

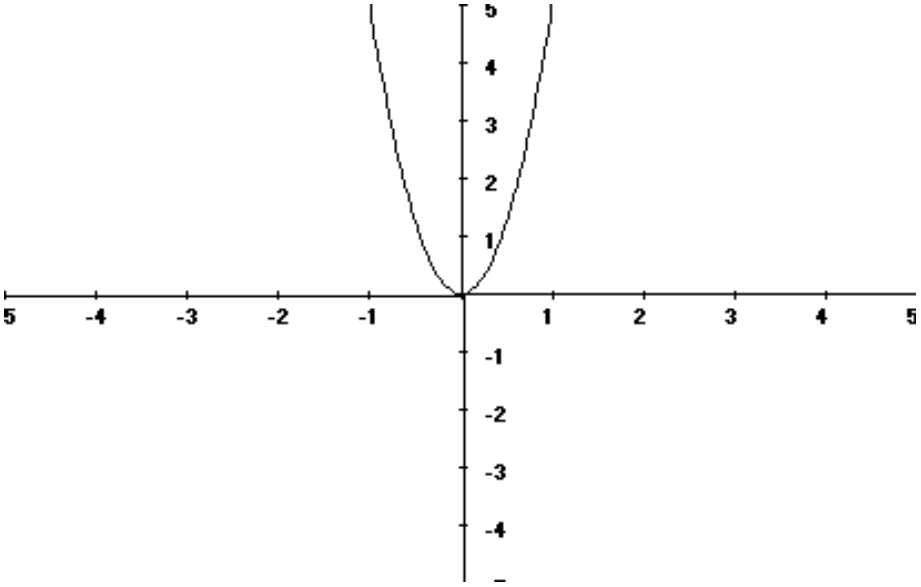
Examples of Essential Tasks

These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

A possible equation for the graph below is:

a) $y = x^2 - 5$ b) $y = 5x$

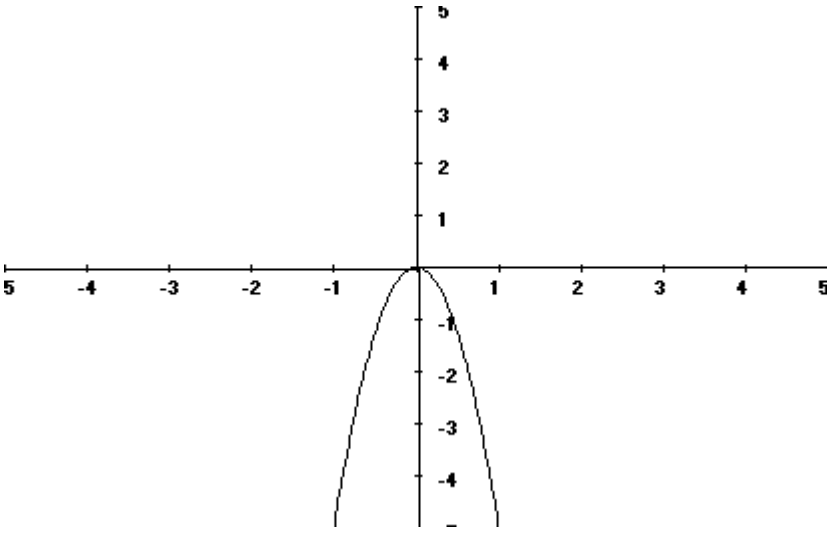
c) $y = -5x^2$ d) $y = 5x^2$



A possible equation for the graph below is:

a) $y = x^2 - 5$ b) $y = 5x$

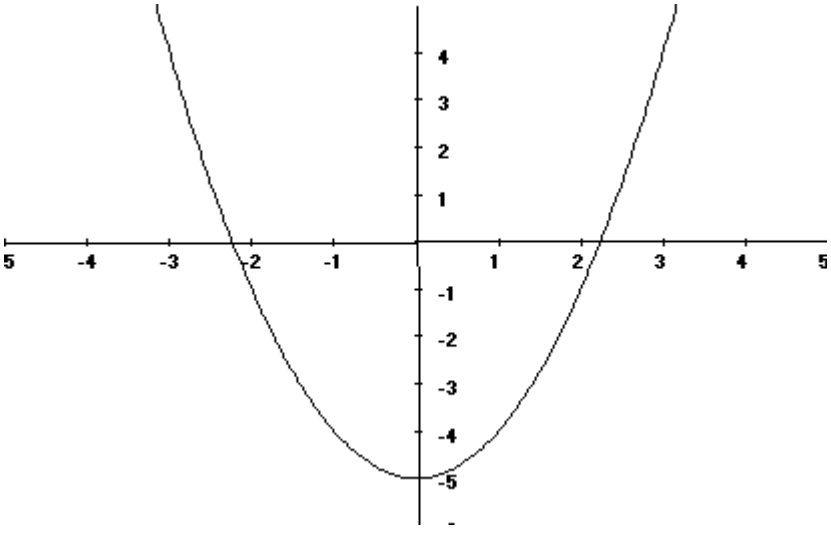
c) $y = -5x^2$ d) $y = 5x^2$



A possible equation for the graph below is:

a) $y = x^2 - 5$ b) $y = x^2 + 5$

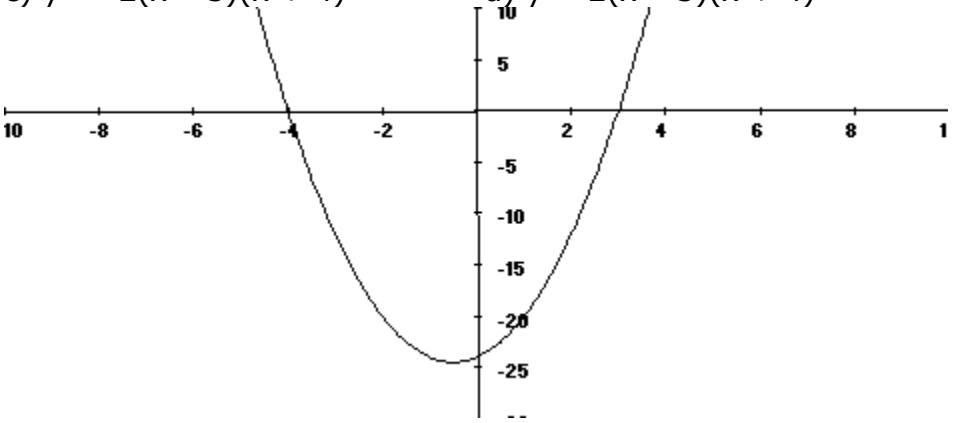
c) $y = -5x^2$ d) $y = 5x^2$



A possible equation for the graph below is:

a) y = -2(x + 3)(x – 4) b) y = 2(x +3)(x – 4)

c) y = -2(x – 3)(x + 4) d) y = 2(x – 3)(x + 4)

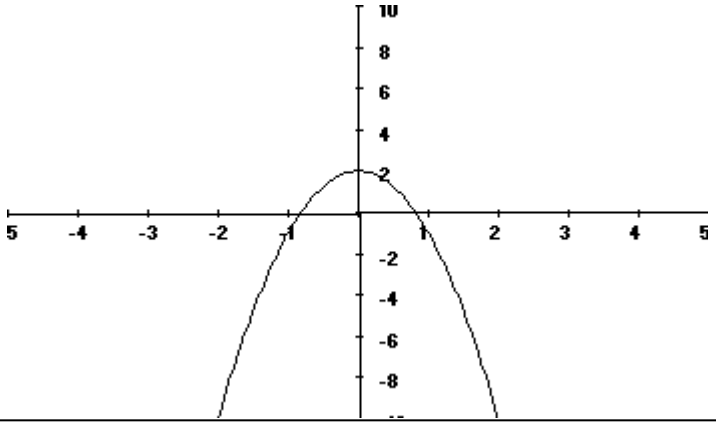


Note: The intent of problems involving matching the graph to the factored form of the equation is that they are done by observation. The factorization should be simple enough that the roots can be determined without algebraic manipulation of the given equation.

A possible equation for the graph below is:

a) $y = 3x^2 - 2$ b) $y = 3x^2 + 2$

c) $y = -3x^2 - 2$ d) $y = -3x^2 + 2$



Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Determine the graphical effect of increasing the magnitude of the leading coefficient in $y = ax^2$.

Determine the graphical effect of decreasing the magnitude of the coefficient in $y = ax^2$.

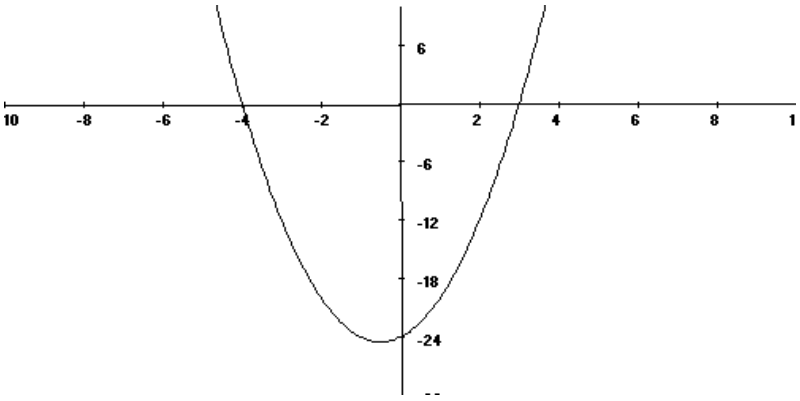
Carry out a procedure to translate between the factored form and standard form of a quadratic equation.

Determine the equation of the quadratic function in standard form.

Factor the quadratic equation.

Examples of Non-Essential Tasks

The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.



Write the equation for the graph above.

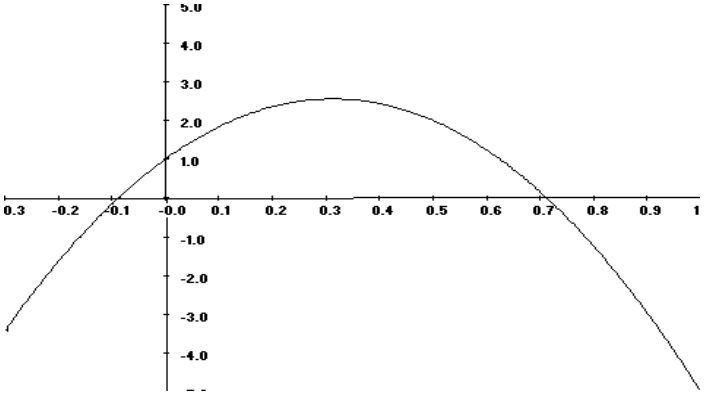
A possible equation for the graph below is:

a) $y = -16t^2 + 10t - 1$

b) $y = -16t^2 + 10t + 1$

c) $y = 16t^2 + 10t + 1$

d) $y = 16t^2 + 10t + 1$



This example is not essential because it requires matching an equation that contains a middle term. This is beyond the scope of the essential expectations of Elementary Algebra.

Misconceptions/Common Errors
None noted

Technology Note
Graphing technology can be used for the converse skills of this indicator:

Graphing $y = ax^2$ or $y = x^2 + c$ and seeing the effect of changing the leading coefficient or constant of the equation is addressed in indicators 6.1 and 6.2, and may be helpful for conveying the concepts involved in this standard.

Graphing equations that are in factored form and having student finde the x-intercepts graphically will help establish the understanding needed to address this indicator.

Assessment Guidelines
The objective of this indicator is to analyze the graph of a quadratic equation to determine its equation.
The primary focus of assessment should be for students to determine how specific qualities of the graph are related to values of leading coefficients, factors and constants in a quadratic equation.

Assessments may require students to use knowledge of how a and c affect the graph and may also focus on distinguishing a possible equation from the graph by using the relationship between the factors of the quadratic equation and the x-intercepts of its graph.

Assessments should not require students to go from a quadratic graph to the standard form of its equation because in elementary algebra students are not required to use algebraic techniques to determine a specified value of a.

EA-6.4 Carry out a procedure to solve quadratic equations by factoring

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Factoring
Roots of a Quadratic Equation

Continuum of Knowledge
In the eighth grade, students apply procedures to solve multistep linear equations (8.34).

In Elementary Algebra, students will solve quadratic equations by the method of factoring.

In Intermediate Algebra, students will carry out a procedure to solve polynomial equations (IA 4.3).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Place a quadratic equation in $0 = ax^2 + bx + c$ form.

Multiply two binomials.

Factor a monomial or constant out of an expression.

Factor a quadratic expression into two binomial factors.

Recognize and factor the difference of two squares.

Recognize and factor the result of squaring a binomial.

Solve a quadratic equation by factoring.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

Solve by factoring: $y = x^2 - 2x + 1$ when y = 0

Solve by factoring: $0 = x^2 - 3x + 2$

Solve by factoring: $y = 5x^2 - 15x + 10$ when y = 0

Solve by factoring: $-1 = 6x^2 + x - 3$

Solve by factoring: $0 = 3x^2 - 12$

Solve by factoring: $y = 4x^2 - 9$ when y = 0

Solve by factoring: $-9 = 4x^2$

Solve by factoring: $y = x^2 - 3x$ when y = -2

Solve by factoring $-2 = x^2 - 3x$

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Know and/or apply the quadratic formula.

Factor a quadratic expression that has a large composite leading coefficient and a composite constant.

Factor a variable to reduce a higher order power to a quadratic.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

Solve by using the quadratic formula: $0 = x^2 - 2x - 2$

Solve $0 = 20x^2 + 7x - 6$ by factoring.

Solve by factoring $y = 3x^3 - 6x$ when y = 0

Misconceptions/Common Errors
Students sometimes disregard leading coefficients when factoring.

Students sometimes think that all quadratics factor.

Technology Note
Students may use graphing utilities to check for the existence of real number solutions.

Students may use computer algebra system technology (calculators or software with symbolic manipulation capabilities) to verify solutions.

Assessment Guidelines
The objective of this indicator is to carry out a specific procedure, factoring, to solve a quadratic equation. Therefore, the primary focus of the assessment should be for students to carry out such procedures in the context of solving an equation.

EA-6.5 Carry out a graphic procedure to approximate the solutions of quadratic equations.

Taxonomy Level
3.1-C
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

Key Concepts
Solutions of a quadratic equation
Quadratic functions

Continuum of Knowledge
In eighth grade, students identify the coordinates of the *x*-intercepts of a linear equation from a graph (8-3.6).

In Elementary Algebra students will estimate the solutions of a quadratic function graphically.

In Pre-Calculus, students will carry out a procedure to solve polynomial equations graphically (PC-3.7).

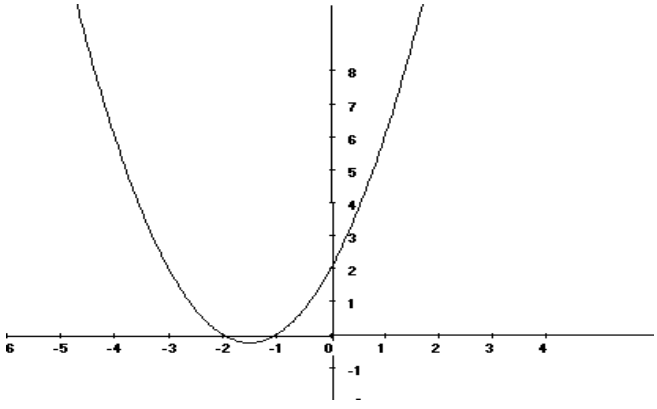
Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Graph a quadratic function.

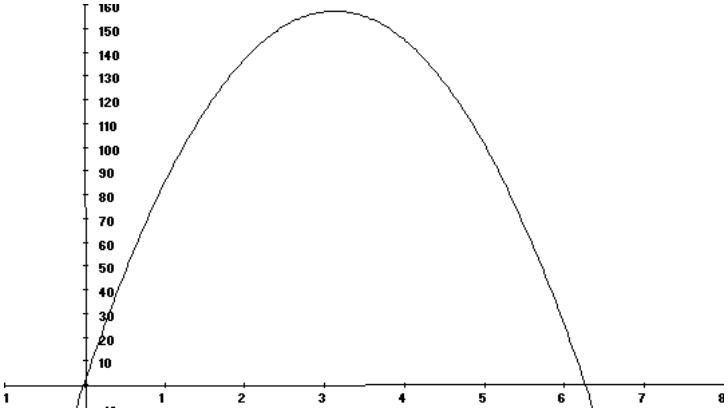
Estimate the zeros of a function from a graph.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

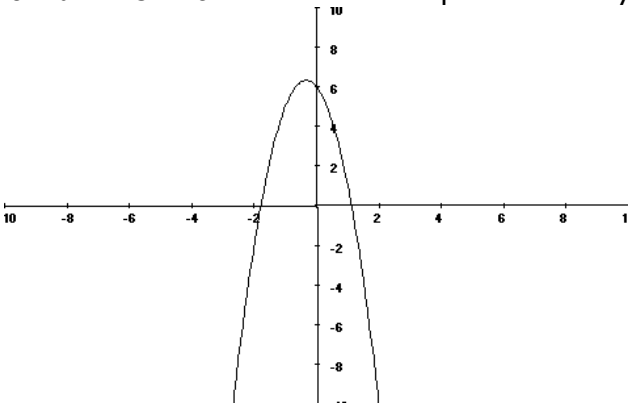
The graph of $y = x^2 + 3x + 2$ is given below. Estimate the solutions of $0 = x^2 + 3x + 2$.



The graph of $y = -16t^2 + 100t + 1$ is given below. Estimate the solutions of $0 = -16t^2 + 100t + 1$.



Estimate the solutions of the quadratic equation in $0 = ax^2 + bx + c$ form that is represented by the graph:



Estimate the solutions to $0 = -16t^2 + 10t + 1$ graphically.

Non-Essential Learning and Understanding

It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Place the equation in $0 = ax^2 + bx + c$ form.

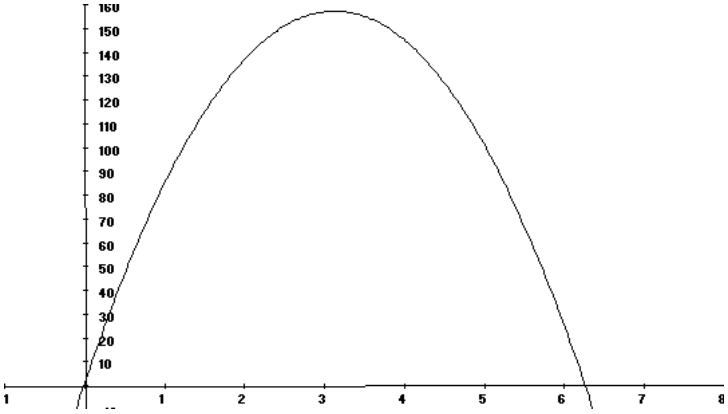
Have irrational answers in radical form. An approximation fulfills the indicator.

Convert repeating decimal answers to fractions. An approximation fulfills the indicator

Examples of Non-Essential Tasks

The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

The graph of $y = -16t^2 + 100t + 1$ is given below. Estimate the solutions of $6 = -16t^2 + 100t + 7$.



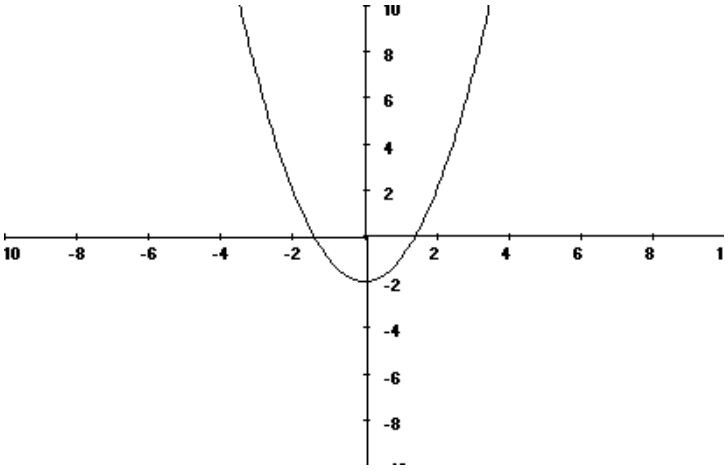
Estimate the solution to $6 = -16t^2 + 10t + 7$ graphically.

Estimate the solution of $0 = x^2 - 2$ graphically. State your answer in radical form.

Estimate the solution of $0 = 2x^2 + 5x + 3$ graphically. State any rational non-integer answers in fractional form.

Choose the solution of a quadratic equation in $x^2 = 2$ represented by the graph of the related function $f(x) = x^2 - 2$ shown below:

a) x = -2 b) x = ± 1 c) x = $\pm\sqrt{2}$ d) x = ± 1.414



Misconceptions/Common Errors
None noted.

Technology Note
Students may use graphing calculators or software to graph and solve the equation. When using technology, the approximate answer given fulfills the indicator. Students are not expected to, and technically should not, assume radical or fractional values from an apparently non-terminating the approximation.

Assessment Guidelines
The objective of this indicator is to carry out a procedure to estimate the solutions of a quadratic equation from the graph of its related function. Therefore, the primary focus of the assessment should be for students to estimate the solutions from a graph. Finding the related function from a given quadratic equation and graphing the function may be necessary steps in this procedure.

EA-6.6 Analyze given information to determine the domain of a quadratic function in a problem situation.

Taxonomy Level
4.3 B
Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

Key Concepts
Domain of a function
Modeling

Continuum of Knowledge
In seventh grade, students generate and solve complex abstract problems that involve modeling physical, social, or mathematical phenomena (7.11). In eighth grade, students identify the coordinates of the *x*- and *y*-intercepts of a linear equation from a graph, equation, and/or table (8-3.6).

In Elementary Algebra students will find the domain of linear and quadratic functions in a problem situation.

In Intermediate Algebra, students will carry out a procedure to determine the domain and range of discontinuous functions (including piecewise and step functions) (IA-2.10).

Essential Learning and Understanding
It is essential for students to do the following for the attainment of this indicator:

Interpret quadratic functions that model a problem situation.

Find the set of x-coordinates that determines the domain of a quadratic function.

Determine the meaningful domain of a quadratic function for a given problem situation.

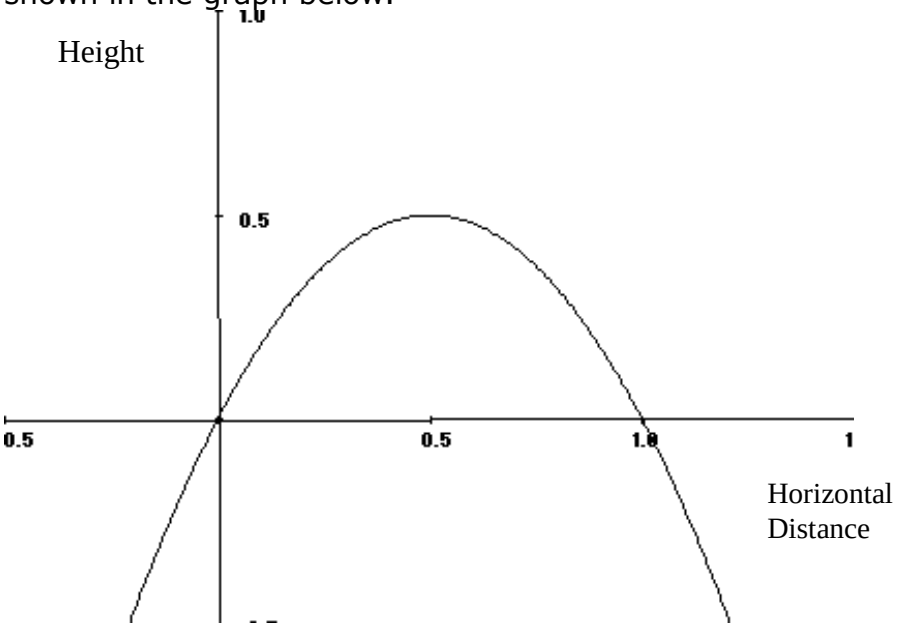
Some problems may require finding the zeros of the function to determine the reasonable domain.

Examples of Essential Tasks
These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

> The area of a rectangle with a perimeter of 500 cm is modeled by the function $A = l^2 - 500l$ where *l* is the length of the rectangle. What is the reasonable domain for this problem?

A steel wrecking ball is dropped from the roof of a 64 foot tall building. The ball's height is modeled by $h = -16t^2 + 64$ where t is time and h is height. Find the domain of the function in this context.

A fish jumps out of the water. His path is given by $h = -2d^2 + 2d$ as shown in the graph below.



What is the domain of the function $h = -2d^2 + 2d$ in this context?

Non-Essential Learning and Understanding
It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:

Generate the modeling function from a verbal description of the problem.

Find the maximum value of the function.

Find the input value that maximizes the function.

Examples of Non-Essential Tasks
The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.

A projectile is shot into the air. Its initial velocity is 10 ft/sec. The projectile is released at a height of 7 feet. The height of a projectile is modeled by the general equation $h = -16t^2 + v\,t + h_0$. What is the domain of the function that models this particular situation?

The area of a rectangle with a perimeter of 500 cm is modeled by the function $A = l(500 - l)$ where *l* is the length of the rectangle and *w* = 500 - *l* is the width. What length maximizes the area?

The revenue for a product is given by
R = (1.25 + .01x)(1000 – 0.20x) where x represents a one-cent increase in price resulting in the loss of 0.2 customers. What price maximizes profit?

A projectile is shot into the air. Its height is modeled by $h = -16t^2 + 10t + 7$ where t is time and h is height. When does the projectile reach its maximum height? What is the maximum height reached?

Misconceptions/Common Errors
Students often misinterpret the meaning of the variables. Specifically, in vertical motion problems where height is a function of time, students believe the graph of the function is the path of the projectile.

Technology Note
Students may use technology (graph or table) to find or estimate zeros.

Assessment Guidelines
The objective of this indicator is to analyze given information to determine the domain of a quadratic function in a problem situation.
Assessment should focus on determining the domain from the constraints of the problem situation.