Minnesota Department of





Grade 8 Mathematics MCA-III Item Sampler Teacher Guide

Grade 8 Mathematics MCA Item Sampler Parent/Teacher Guide

Education

The purpose of the Item Samplers is to familiarize students with the online MCA test format. The Item Samplers contain multiple choice items (MC) and technology enhanced items (TE).

This guide includes:

- A snapshot of each item
- Benchmark and examples from the Minnesota Academic Standards for Mathematics
- Item specifications (Content limits contained in the item specifications are intended for use by item developers. They should not be construed as instructional limits.)
- Vocabulary
- Depth of Knowledge (DOK) see more detail below
- Calculator designation (CL = calculator allowed; NC = no calculator)
- Correct answer
- Table of rationales (explanations for why a student might choose each incorrect answer option, e.g., mixed up addition and subtraction, used incorrect place value, etc.)
- Notes on grade expectations for some items

Cognitive Complexity/Depth of Knowledge (DOK)

Cognitive complexity refers to the cognitive demand associated with an item. The level of cognitive demand focuses on the type and level of thinking and reasoning required of the student on a particular item. Levels of cognitive complexity for MCA-III are based on Norman L. Webb's Depth of Knowledge¹ levels.

Level 1 (recall) items require the recall of information such as a fact, definition, term or simple procedure, as well as performing a simple algorithm or applying a formula. A well-defined and straight algorithmic procedure is considered to be at this level. A Level 1 item specifies the operation or method of solution and the student is required to carry it out.

¹ Webb, N. L. *Alignment of science and mathematics standards and assessments in four states* (Research Monograph No. 18). Madison: University of Wisconsin – Madison, National Institute for Science Education, 1999.

Level 2 (skill/concept) items call for the engagement of some mental processing beyond a habitual response, with students required to make some decisions as to how to approach a problem or activity. Interpreting information from a simple graph and requiring reading information from the graph is a Level 2. An item that requires students to choose the operation or method of solution and then solve the problem is a Level 2. Level 2 items are often similar to examples used in textbooks.

Level 3 (strategic thinking) items require students to reason, plan or use evidence to solve the problem. In most instances, requiring students to explain their thinking is a Level 3. A Level 3 item may be solved using routine skills but the student is not cued or prompted as to which skills to use.

Level 4 (extended thinking) items require complex reasoning, planning, developing and thinking, most likely over an extended period of time. Level 4 items are best assessed in the classroom, where the constraints of standardized testing are not a factor.

Technology Enhanced Items

There are several types of technology enhanced items. To respond to these questions, students may be required to type a number into a blank, select their answer choice(s), or select and drag. When typing an answer into a blank, the test engine allows students to type in numbers, the division bar (/), decimal points, and negative signs (in certain grades only). The test engine does not allow students to type in other characters, symbols, or letters of the alphabet.

Grade 8 Mathematics MCA Item Sampler Answer Key

ltem #	Correct Answer	ltem Type	Benchmark	Calculator
1	С	MC	8.2.1.4	CL
2	В	MC	8.2.2.2	CL
3	D	MC	8.2.2.3	CL
4	С	MC	8.2.2.5	CL
5	С	MC	8.2.3.2	CL
6	D	MC	8.2.4.3	CL
7	N/A	TE	8.2.4.6	CL
8	В	MC	8.2.4.7	CL
9	С	MC	8.3.1.2	CL
10	D	MC	8.1.1.1	NC
11	N/A	TE	8.1.1.2	NC
12	С	MC	8.1.1.4	NC
13	D	MC	8.1.1.5	NC
14	С	MC	8.2.1.1	NC
15	В	MC	8.2.1.2	NC
16	С	MC	8.2.2.1	NC
17	В	MC	8.2.4.4	NC
18	N/A	TE	8.3.2.1	NC
19	A	MC	8.3.2.2	NC
20	N/A	TE	8.2.1.3	CL
21	D	MC	8.2.1.5	CL
22	D	MC	8.2.2.4	CL
23	В	MC	8.2.3.1	CL
24	С	MC	8.2.4.1	CL
25	A	MC	8.2.4.2	CL
26	В	MC	8.2.4.5	CL
27	N/A	TE	8.3.1.1	CL
28	В	MC	8.3.2.3	CL
29	В	MC	8.4.1.2	CL
30	N/A	TE	8.2.1.2	CL
31	N/A	TE	8.2.4.5	CL

Which sequence is arithmetic?

A. 4 8 16 32 64
B. 11 12 14 17 21

 \odot C. 28 15 2 -11 -24

 \bigcirc D. 30 -25 20 -15 10

Benchmark: 8.2.1.4

Understand that an arithmetic sequence is a linear function that can be expressed in the form f(x) = mx + b, where x = 0, 1, 2, 3, ...

For example: The arithmetic sequence 3, 7, 11, 15, ..., can be expressed as f(x) = 4x + 3.

Item Specifications

- Vocabulary allowed in items: *n*th term, arithmetic sequence, geometric sequence, linear function, non-linear function, progression, common difference, and vocabulary given at previous grades
- Allowable notation: items must specify the domain as x = 0, 1, 2, 3, ... or x = 1, 2, 3, 4, ...

DOK: 2 Calculator: CL Answer: C

А	Mixed up arithmetic with geometric. To find the next term in the sequence, multiply by 2.
В	Arithmetic sequences have the same difference between each consecutive term.
	This is a growing pattern; the differences are 1, 2, 3, 4,
С	Correct. To find the next term in the sequence, add -13 .
D	This is a two-rule pattern. The odd-numbered terms use the rule: add -10 ; the
	even-numbered terms use the rule: add 10.

Notes on grade expectations: Student should be able to determine whether a sequence is arithmetic, geometric, or other by looking at consecutive terms or by finding differences. Student should be able to generate terms of a sequence using the given the domain.



Benchmark: 8.2.2.2

Identify graphical properties of linear functions including slopes and intercepts. Know that the slope equals the rate of change, and that the *y*-intercept is zero when the function represents a proportional relationship.

Item Specifications

- Coordinates used for determining slope must contain integer values
- Vocabulary allowed in items: linear function, intercept, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

Α	The weight of each marble is the slope, not the <i>y</i> -intercept.
В	Correct. The y-intercept represents the weight of the jar with 0 marbles in it.
С	The <i>x</i> -intercept—not the <i>y</i> -intercept— is where the weight equals 0. In this situation, when the <i>x</i> -intercept is 0, the <i>y</i> -value is negative. A negative number of marbles is not possible.
D	Mixed up <i>x</i> - and <i>y</i> -axes. The <i>y</i> -intercept represents the weight of the jar with 0 marbles in it, not with 10 marbles in it.

Notes on grade expectations: Student should be able to interpret the meaning of points, slope and *y*-intercept for linear functions in terms of the context.

An equation is shown. m = 4p + 3When p is increased by 2, how much does m increase? A. 2 B. 4 C. 7 D. 8

Benchmark: 8.2.2.3

Identify how coefficient changes in the equation f(x) = mx + b affect the graphs of linear functions. Know how to use graphing technology to examine these effects.

Item Specifications

• Vocabulary allowed in items: linear function, intercept, coefficient, constant, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: D

Α	Did not multiply the change by 4.
В	Used coefficient of 4 from equation.
С	Added 4 + 3 from equation.
D	Correct. Since p is multiplied by 4, when p increases by 2, m would increase by
	$2 \times 4 = 8$

Notes on grade expectations: Student should be able to describe the effect on the dependent variable given a change to the independent variable.

 A sequence is shown.

 1.5
 4.5
 13.5
 40.5

 What is the seventh term in the sequence?

 •
 A. 121.5

 •
 B. 364.5

 •
 D. 3,280.5

Benchmark: 8.2.2.5

Represent geometric sequences using equations, tables, graphs and verbal descriptions, and use them to solve problems.

For example: If a girl invests 100 at 10% annual interest, she will have $100(1.1)^x$ dollars after x years.

Item Specifications

• Vocabulary allowed in items: *n*th term, arithmetic sequence, geometric sequence, linear function, non-linear function, progression, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: C

А	Found the next term (5 th) instead of the 7 th .
В	Found the 6 th term instead of the 7 th .
С	Correct. Since the rule is $\times 3$, multiply 40.5 by 3 three times; 40.5(3) ³ .
D	Found the 8 th term instead of the 7 th .

Notes on grade expectations: Given consecutive terms of a geometric sequence, student should be able to determine the rule and generate additional terms. Find the common ratio by dividing each term by the previous term.

Which property is used in the equation mg + mh = m(g + h)?
A. Associative
B. Commutative
C. Distributive
D. Identity

Benchmark: 8.2.3.2

Justify steps in generating equivalent expressions by identifying the properties used, including the properties of algebra. Properties include the associative, commutative and distributive laws, and the order of operations, including grouping symbols.

Item Specifications

- Items must not have context
- Vocabulary allowed in items: associative, commutative, distributive, identity, property, order of operations, and vocabulary given at previous grades

DOK: 1 Calculator: CL Answer: C

А	Chose incorrect property.
В	Chose incorrect property.
С	Correct. The Distributive Property is shown.
D	Chose incorrect property.

Which is the equation of the same line as y = 3x - 8? A. 3x - 2y = 8B. -3x - 2y = -8C. 6x - y = 16D. 6x - 2y = 16

Benchmark: 8.2.4.3

Express linear equations in slope-intercept, point-slope and standard forms, and convert between these forms. Given sufficient information, find an equation of a line. *For example*: Determine an equation of the line through the points (-1,6) and $(\frac{2}{3}, -\frac{3}{4})$.

Item Specifications

- Items must not have context
- Vocabulary allowed in items: slope-intercept form, point-slope form, standard form, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: D

Α	Multiplied y by 2 without multiplying any other terms by 2.
В	Multiplied y by -2 without multiplying any other terms by -2 .
С	Did not multiply y by 2.
D	Correct.

Notes on grade expectations: Student should be able to compare equations in different forms to determine equivalence.

An equation is shown.
2x-4 =6
The equation has 2 solutions. One solution is $x=5$. What is the other solution?
Enter your answer in the box.

Benchmark: 8.2.4.6

Represent relationships in various contexts with equations and inequalities involving the absolute value of a linear expression. Solve such equations and inequalities and graph the solutions on a number line.

For example: A cylindrical machine part is manufactured with a radius of 2.1 cm, with a tolerance of $\frac{1}{100}$ cm. The radius *r* satisfies the inequality $|r - 2.1| \le .01$.

Item Specifications

· Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer:

This is a technology-enhanced item. The correct answer is shown. A student must type the correct answer in the box in order to receive 1 point.

An equation is shown.
2x-4 =6
The equation has 2 solutions. One solution is $x=5$. What is the other solution?
Enter your answer in the box.
-1

Notes on grade expectations: Solve 2x - 4 = 6 to get x = 5. Solve 2x - 4 = -6 to get x = -1.

Note: The allowable characters that can be entered in the answer box are digits 0-9, fraction bar (/), decimal point (.), and negative sign (-). Students cannot enter a comma in numbers with more than 3 digits. Familiarity with calculators will help the students with this concept.

Lisa has 5 more green marbles than blue marbles. She has a total of 40 green and blue marbles. Which system of equations represents this situation if x is the number of green marbles and y is the number of blue marbles?

A. $\left\{egin{array}{l} y=x+5\ x+y=40 \end{array} ight.$	۲	B. $\left\{egin{array}{l} x=y+5 \ x+y=40 \end{array} ight.$
^{C.} $\left\{egin{array}{l} y=x+5 \ y=x+40 \end{array} ight.$	0	D. $\left\{egin{array}{l} x=y+5\ x=y+40 \end{array} ight.$

Benchmark: 8.2.4.7

Represent relationships in various contexts using systems of linear equations. Solve systems of linear equations in two variables symbolically, graphically and numerically. *For example*: Marty's cell phone company charges **\$15** per month plus **\$0.04** per minute for each call. Jeannine's company charges **\$0.25** per minute. Use a system of equations to determine the advantages of each plan based on the number of minutes used.

Item Specifications

• Vocabulary allowed in items: system of equations, undefined, infinite, intersecting, identical, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

А	Top equation has x and y mixed up.
В	Correct.
С	Top equation has x and y mixed up. Bottom equation should be $x + y = 40$.
D	Bottom equation should be $x + y = 40$.

What is the distance between (4, 7) and (-3, 9) on a coordinate grid? • A. $\sqrt{5}$ • B. $\sqrt{45}$ • C. $\sqrt{53}$ • D. $\sqrt{305}$

Benchmark: 8.3.1.2

Determine the distance between two points on a horizontal or vertical line in a coordinate system. Use the Pythagorean Theorem to find the distance between any two points in a coordinate system.

Item Specifications

- Graphs are not provided when finding horizontal or vertical distance
- Vocabulary allowed in items: Pythagorean Theorem and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: C

A	Found square root of $[(7 - 9) + (43)] = \sqrt{5}$ but did not square the parentheses.
B	Subtracted the squares instead of adding;
D	square root of $[(-3 - 4)^2 - (9 - 7)^2] = \sqrt{45}$
С	Correct. Square root of $[(-3-4)^2 + (9-7)^2] = \sqrt{53}$
D	Added y ₁ and y ₂ instead of subtracting;
	square root of $[(-3 - 4)^2 + (9 + 7)^2] = \sqrt{305}$

Notes on grade expectations: Student should be able to find the distance between two points on a coordinate plane using the distance formula, $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$, or the Pythagorean Theorem. Both formulas are on the grade 8 formula sheet.

Which expression results in a rational number? • A. $1.5 + \sqrt{1.5}$ • B. $12 - \sqrt{12}$ • C. $\frac{3}{4} \cdot \sqrt{\frac{3}{4}}$ • D. $25 \div \sqrt{25}$

Benchmark: 8.1.1.1

Classify real numbers as rational or irrational. Know that when a square root of a positive integer is not an integer, then it is irrational. Know that the sum of a rational number and an irrational number is irrational, and the product of a non-zero rational number and an irrational number is irrational.

For example: Classify the following numbers as whole numbers, integers, rational numbers, irrational numbers, recognizing that some numbers belong in more than one

category:
$$\frac{6}{3}, \frac{3}{6}, 3.\overline{6}, \frac{\pi}{2}, -\sqrt{4}, \sqrt{10}, -6.7$$
.

Item Specifications

- Allowable notation: $\sqrt{18}$
- Vocabulary allowed in items: irrational, real, square root, radical, and vocabulary given at previous grades

DOK: 1 Calculator: NC Answer: D

A	The number is not rational because the square root of 1.5 is an irrational number and the sum of a rational number and an irrational number is an irrational number.
В	The number is not rational because the square root of 12 is an irrational number and the difference of a rational number and an irrational number is an irrational number.
С	The number is not rational because the square root of $\frac{3}{4}$ is an irrational number and the product of a rational number and an irrational number is an irrational number.
D	Correct. The square root of 25 simplifies to 5; $25/5 = 5$



Benchmark: 8.1.1.2

Compare real numbers; locate real numbers on a number line. Identify the square root of a positive integer as an integer, or if it is not an integer, locate it as a real number between two consecutive positive integers.

For example: Put the following numbers in order from smallest to largest:

2, √3 , -4, -6.8, -√37 .

Another example: $\sqrt{68}$ is an irrational number between 8 and 9.

Item Specifications

- Allowable notation:
- Vocabulary allowed in items: square root, radical, consecutive, and vocabulary given at previous grades

DOK: 1 Calculator: NC Answer:

This is a technology-enhanced item. The correct answer is shown. A student must select both points on the number line in order to receive 1 point.



Notes on grade expectations: Student can use knowledge of perfect squares to estimate the value of $\sqrt{3}$. Knowing that $\sqrt{3}$ falls between $\sqrt{1}$ and $\sqrt{4}$, and that 1 and 4 are perfect squares, then $\sqrt{1} = 1$ and $\sqrt{4} = 2$, so the value of $\sqrt{3}$ must be between 1 and 2.

Simplify. (4x)² - 4x³ A. x^{-1} B. $12x^{-1}$ C. $16x^2 - 4x^3$ D. $16x^2 - 64x^3$

Benchmark: 8.1.1.4

Know and apply the properties of positive and negative integer exponents to generate equivalent numerical expressions.

For example:
$$3^2 \times 3^{(-5)} = 3^{(-3)} = \left(\frac{1}{3}\right)^3 = \frac{1}{27}$$
.

Item Specifications

- Allowable notation: −x², (−x)², −3², (−3)²
- Expressions may be numeric or algebraic
- Vocabulary allowed in items: vocabulary given at previous grades

DOK: 1 Calculator: NC Answer: C

А	Did not square the 4 in parentheses and used division instead of subtraction; $4x^2/4x^3$.
В	Subtracted unlike terms to get $16 - 4 = 12$. Divided x^2 by x^3 instead of subtracting.
С	Correct.
D	Cubed the 4 that is not in parentheses; Found $(4x)^2 - (4x)^3$ instead of $(4x)^2 - 4x^3$.

Notes on grade expectations: Student should know how to combine like terms and how to use the order of operations from grade 7.

Simplify.	
	$\frac{1.2 \times 10^{-6}}{4.8 \times 10^4}$
\odot A. $2.5 imes10^{-2}$	
\odot B. $2.5 imes10^{-9}$	
\odot C. $2.5 imes10^{-10}$	
\odot D. $2.5 imes 10^{-11}$	

Benchmark: 8.1.1.5

Express approximations of very large and very small numbers using scientific notation; understand how calculators display numbers in scientific notation. Multiply and divide numbers expressed in scientific notation, express the answer in scientific notation, using the correct number of significant digits when physical measurements are involved. *For example*: $(4.2 \times 10^4) \times (8.25 \times 10^3) = 3.465 \times 10^8$, but if these numbers represent physical measurements, the answer should be expressed as 3.5×10^8 because the first factor, 4.2×10^4 , only has two significant digits.

Item Specifications

• Vocabulary allowed in items: scientific notation, significant digits, standard form, and vocabulary given at previous grades

DOK: 2 Calculator: NC Answer: D

А	Found exponent using $-6 + 4$ instead of $-6 - 4$. Did not adjust exponent of 10 after rewriting 0.25 as 2.5.
В	Found 0.25 \times 10 ⁻¹⁰ , but did not rewrite as 2.5 \times 10 ⁻¹¹ . Added 1 to exponent of -10 instead of subtracting 1.
С	Found 0.25 \times 10 ⁻¹⁰ , but did not rewrite as 2.5 \times 10 ⁻¹¹ .
D	Correct.

Notes on grade expectations: Student should know that in scientific notation, $a \times 10^{b}$, the absolute value of *a* must be greater than or equal to 1 and less than 10.



Benchmark: 8.2.1.1

Understand that a function is a relationship between an independent variable and a dependent variable in which the value of the independent variable determines the value of the dependent variable. Use functional notation, such as f(x), to represent such relationships.

For example: The relationship between the area of a square and the side length can be expressed as $f(x) = x^2$. In this case, f(5) = 25, which represents the fact that a square of side length 5 units has area 25 units squared.

Item Specifications

• Vocabulary allowed in items: independent, dependent, constant, coefficient, and vocabulary given at previous grades

DOK: 1 Calculator: NC Answer: C

Α	For each <i>x</i> -value, there is only 1 <i>y</i> -value.
В	For each <i>x</i> -value, there is only 1 <i>y</i> -value.
С	Correct. For the x-value of 0, there is more than 1 y-value.
D	For each <i>x</i> -value, there is only 1 <i>y</i> -value.

Notes on grade expectations: Student should know that in a function, there is exactly 1 y-value for every x-value. Student should know that the vertical line test may be used to determine if a graph is a function.

The number of cakes needed for a party, *c*, is dependent upon the number of guests at the party, *g*. Which equation shows the number of cakes as a function of the number of guests?

A. f(c) = $\frac{g}{12}$ B. f(g) = $\frac{g}{12}$ C. f(c) = $\frac{c}{12}$ D. f(g) = $\frac{c}{12}$

Benchmark: 8.2.1.2

Use linear functions to represent relationships in which changing the input variable by some amount leads to a change in the output variable that is a constant times that amount.

For example: Uncle Jim gave Emily \$50 on the day she was born and \$25 on each birthday after that. The function f(x) = 50 + 25x represents the amount of money Jim has given after x years. The rate of change is \$25 per year.

Item Specifications

 Vocabulary allowed in items: independent, dependent, constant, coefficient, and vocabulary given at previous grades

DOK: 1 Calculator: NC Answer: B

А	Used $f(c)$ instead of $f(g)$. A function of g uses $f(g)$.
В	Correct.
C	Used c instead of g as the independent variable, and $f(c)$ instead of $f(g)$ as the
C	dependent variable.
D	Used c instead of g as the independent variable.

Notes on grade expectations: Student should know that in a function, the dependent variable is determined by the independent variable. Using function notation, if the independent variable is t, then the dependent variable is f(t).



Benchmark: 8.2.2.1

Represent linear functions with tables, verbal descriptions, symbols, equations and graphs; translate from one representation to another.

Item Specifications

Vocabulary allowed in items: linear function, and vocabulary given at previous grades

DOK: 2 Calculator: NC Answer: C

А	Used (2, 10) and interpreted y-axis as rate instead of cost.
В	Interpreted axes correctly, but used the point (8, 60) instead of (8, 40).
С	Correct. The graph has a slope of 5. $(30 - 0)/(6 - 0) = 30/6 = 5$
D	Thought 40 was the y-intercept.

Notes on grade expectations: Student should be able to interpret the meaning of points, slope, and *y*-intercept in linear function in terms of the context.

Ann sells bracelets for \$4 each and necklaces for \$8 each. Which inequality shows x, the number of bracelets, and y, the number of necklaces Ann must sell to make at least \$100?

A. $4x + 8y \le 100$ B. $4x + 8y \ge 100$ C. $8x + 4y \le 100$ D. $8x + 4y \ge 100$

Benchmark: 8.2.4.4

Use linear inequalities to represent relationships in various contexts.

For example: A gas station charges **\$0.10** less per gallon of gasoline if a customer also gets a car wash. Without the car wash, gas costs **\$2.79** per gallon. The car wash is **\$8.95**. What are the possible amounts (in gallons) of gasoline that you can buy if you also get a car wash and can spend at most **\$35**?

Item Specifications

- Inequalities contain no more than 1 variable
- Vocabulary allowed in items: vocabulary given at previous grades

DOK: 1 Calculator: NC Answer: B

А	Reversed inequality symbol.
В	Correct.
С	Mixed up <i>x</i> and <i>y</i> . Reversed inequality symbol.
D	Mixed up x and y.



Benchmark: 8.3.2.1

Understand and apply the relationships between the slopes of parallel lines and between the slopes of perpendicular lines. Dynamic graphing software may be used to examine these relationships.

Item Specifications

Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: NC Answer:

This is a technology-enhanced item. The correct answer is shown. A student must select both of the correct equations in order to receive 1 point.



Notes on grade expectations: Student should know that perpendicular lines have opposite reciprocal slopes. In this situation, since the slope of the given line is $\frac{1}{2}$, select equations with slope of -2.

A rectangle is drawn on a coordinate grid. The equation for 1 side of the rectangle is 3x - 2y = 12. Which could be an equation for another side of the rectangle?

Benchmark: 8.3.2.2

Analyze polygons on a coordinate system by determining the slopes of their sides. *For example*: Given the coordinates of four points, determine whether the corresponding quadrilateral is a parallelogram.

Item Specifications

Vocabulary allowed in items: vocabulary given at previous grades

DOK: 3 Calculator: NC Answer: A

А	Correct. The slope of the given line is $\frac{3}{2}$, so the other sides must have the same
	slope (parallel sides) or the opposite reciprocal slope, $-\frac{2}{3}$ (perpendicular sides).
В	Has slope of 3 instead of $\frac{3}{2}$ or $-\frac{2}{3}$.
С	Has slope of $-\frac{3}{2}$ instead of $\frac{3}{2}$ or $-\frac{2}{3}$.
D	Has slope of 2 instead of $\frac{3}{2}$ or $-\frac{2}{3}$.

Notes on grade expectations: Student should know definitions of polygons from previous grades. Rectangles have 2 sets of parallel sides. Since rectangles have 4 right angles, the sets of sides are perpendicular to each other. Student should know that parallel lines have equivalent slopes and perpendicular lines have opposite reciprocal slopes.

This item is DOK 3 because several decisions are required before proceeding. Student must understand the relationships between the slopes of the sides of a rectangle. Students must be able to determine the slope of the line represented by the given equation; this most likely requires changing the equation into slope-intercept form (y = mx + b). Then students will determine what the slopes of the parallel and perpendicular lines could be and find an equation containing those.



Benchmark: 8.2.1.3

Understand that a function is linear if it can be expressed in the form f(x) = mx + b or if its graph is a straight line.

For example: The function $f(x) = x^2$ is not a linear function because its graph contains the points (1,1), (-1,1) and (0,0), which are not on a straight line.

Item Specifications

 Vocabulary allowed in items: linear, constant, coefficient, and vocabulary given at previous grades

DOK: 1 Calculator: CL Answer:

This is a technology-enhanced item. The correct answer is shown. A student must place each relationship into the correct box in order to receive 1 point.

Determine if the relationships are linear or nonlinear.





Notes on grade expectations:

A relationship is linear if:

- the equation can be expressed in the form: f(x) = mx + b, or
- the graph is a straight line, or
- the greatest exponent of the independent variable in the equation is 1

A relationship is nonlinear if:

- the equation can be expressed in a form other than f(x) = mx + b, or
- the graph is not a straight line, or
- the greatest exponent of the independent variable in the equation is greater than 1

Which function forms a geometric sequence when $x=1,\,2,\,3,\,\ldots$?

A.
$$f(x) = x + 2$$
B. $f(x) = x^2$
C. $f(x) = x^2 + 2$
D. $f(x) = 2^x$

Benchmark: 8.2.1.5

Understand that a geometric sequence is a non-linear function that can be expressed in the form $f(x) = ab^x$, where x = 0, 1, 2, 3, ...

For example: The geometric sequence $6, 12, 24, 48, \dots$, can be expressed in the form $f(x) = 6(2^x)$.

Item Specifications

- Vocabulary allowed in items: *n*th term, arithmetic sequence, geometric sequence, linear function, non-linear function, exponential, progression, common ratio, and vocabulary given at previous grades
- Allowable notation: items must specify the domain as x = 0, 1, 2, 3, ... or x = 1, 2, 3, 4,

DOK: 2 Calculator: CL Answer: D

А	Equation is not in the form $f(x) = ab^x$. The terms 3, 4, 5, have a common
	difference (arithmetic sequence), not a common ratio.
В	Confused x^2 with 2^x . There is no common ratio between the terms 1, 4, 9,
С	Confused x^2 with 2^x . There is no common ratio between the terms 3, 6, 11,
D	Correct. Equation is in the form $f(x) = ab^x$. The terms in the sequence,
	2, 4, 8, 16, 32, 64 can be generated using a common ratio of 2 (i.e., $2 \times 2 = 4$,
	$4 \times 2 = 8, 8 \times 2 = 16$, etc.).

Notes on grade expectations: Student should be able to determine whether a sequence is arithmetic, geometric, or other by looking at the equation or consecutive terms in the sequence. A geometric sequence has a common ratio between consecutive terms.

A sequence is shown.

-1 -7 -13 -19 -25

What is the function rule for the sequence?

• A.
$$f(x) = x - 6$$

• B. $f(x) = -6x$

 \odot C. f(x) = 5x - 6

• D.
$$f(x) = -6x + 5$$

Benchmark: 8.2.2.4

Represent arithmetic sequences using equations, tables, graphs and verbal descriptions, and use them to solve problems.

For example: If a girl starts with \$100 in savings and adds \$10 at the end of each month, she will have 100 + 10x dollars after x months.

Item Specifications

• Vocabulary allowed in items: *n*th term, arithmetic sequence, geometric sequence, linear function, non-linear function, progression, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: D

Α	Found constant difference of -6 , then attempted to write as a recursive formula.
В	Ignored initial term in sequence; only used change (slope).
С	Mixed up slope and y-intercept.
D	Correct. Constant difference of -6 equals slope; use $y = mx + b$ or find 0 th
	term to find y-intercept of 5.

Notes on grade expectations: Student should be able to determine whether a sequence is arithmetic, geometric, or other by looking at consecutive terms or by finding differences. Student should be able to write a function rule for the sequence.

What is the value of -3 |-2x - y| when x = -4 and y = 5? • A. -27• B. -9• C. 9 • D. 27

Benchmark: 8.2.3.1

Evaluate algebraic expressions, including expressions containing radicals and absolute values, at specified values of their variables.

For example: Evaluate $\pi r^2 h$ when r = 3 and h = 0.5, and then use an approximation of π to obtain an approximate answer.

Item Specifications

- Items must not have context
- Directives may include: simplify, evaluate
- Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

А	May have ignored -2 and calculated $-3 -4 - 5 $.
В	Correct. $-3 -2(-4)-5 = -3 8-5 = -3 3 = -3(3) = -9$
С	Mixed up +/- sign.
D	May have ignored -2 and absolute value signs calculating $-3(-4 - 5)$.

Notes on grade expectations: Student should know the order of operations from previous grades.

Leon plants 3 rows of tomatoes with n plants in each row. He also plants 1 row of beans with 5 plants in the row. Which equation can be used to find t, the total number of plants Leon planted?

A. t = n + 8B. t = 3n + 1C. t = 3n + 5D. t = 5n + 3

Benchmark: 8.2.4.1

Use linear equations to represent situations involving a constant rate of change, including proportional and non-proportional relationships.

For example: For a cylinder with fixed radius of length 5, the surface area $A = 2\pi(5)h + 2\pi(5)^2 = 10\pi h + 50\pi$, is a linear function of the height *h*, but the surface area is not proportional to the height.

Item Specifications

· Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: C

А	Combined $3n + 5$ as $3 + n + 5 = n + 8$.
В	For beans, used 1 row instead of 1 row x 5 plants.
С	Correct.
D	Thought there were 5 rows of <i>n</i> tomatoes and 1 row of beans with 3 plants in each row.

What is the value of p when 2p + 10 = 24? • A. p = 7• B. p = 12• C. p = 17• D. p = 28

Benchmark: 8.2.4.2

Solve multi-step equations in one variable. Solve for one variable in a multi-variable equation in terms of the other variables. Justify the steps by identifying the properties of equalities used.

For example: The equation 10x + 17 = 3x can be changed to 7x + 17 = 0, and then to 7x = -17 by adding/subtracting the same quantities to both sides. These changes do not change the solution of the equation.

Another example: Using the formula for the perimeter of a rectangle, solve for the base in terms of the height and perimeter.

Item Specifications

• Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: A

А	Correct. $2p + 10 = 24$; $2p = 14$; $p = 7$
В	Subtracted 2 from both sides instead of dividing by 2; treated $2p$ as $2 + p$.
С	Added 10 to both sides instead of subtracting.
D	Multiplied both sides by 2 instead of dividing by 2.

A number line is shown. $\begin{array}{c} & & & & \\ \hline -4 & -3 & -2 & -1 & 0 & 1 & 2 & 3 & 4 \\ \hline -4 & -3 & -2 & -1 & 0 & 1 & 2 & 3 & 4 \\ \hline \end{array}$ Which equation has the solution shown on the number line? $\begin{array}{c} & & & \\ \mathbb{A} & -4 > x > -2 \\ \hline \\ \mathbb{B} & & & \\ 4 < -2x < 8 \\ \hline \\ \mathbb{B} & & & \\ \mathbb{C} & & & \\ 4 > -2x > 8 \\ \hline \\ \mathbb{D} & -4 < 2x < -8 \end{array}$

Benchmark: 8.2.4.5

Solve linear inequalities using properties of inequalities. Graph the solutions on a number line.

For example: The inequality -3x < 6 is equivalent to x > -2, which can be represented on the number line by shading in the interval to the right of -2.

Item Specifications

• Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

А	Reversed inequality symbols.
В	Correct. Equivalent to $-4 < x < -2$ (multiplied by -2).
С	Did not reverse inequality symbols when multiplying by negative number.
D	Reversed inequality symbols.



Benchmark: 8.3.1.1

Use the Pythagorean Theorem to solve problems involving right triangles.

For example: Determine the perimeter of a right triangle, given the lengths of two of its sides.

Another example: Show that a triangle with side lengths 4, 5 and 6 is not a right triangle.

Item Specifications

- Congruent angle marks may be used
- Vocabulary allowed in items: Pythagorean Theorem and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer:

This is a technology-enhanced item. The correct answer is shown. A student must type the correct answer in the box in order to receive 1 point.



Notes on grade expectations: Student finds the hypotenuse using the Pythagorean Theorem: $\sqrt{(6^2 + 5^2)} = \sqrt{(36 + 25)} = \sqrt{61} \approx 7.8102$

Note: The allowable characters that can be entered in the answer box are digits 0-9, fraction bar (/), decimal point (.), and negative sign (-). Students cannot enter a comma in numbers with more than 3 digits. Familiarity with calculators will help the students with this concept.



Benchmark: 8.3.2.3

Given a line on a coordinate system and the coordinates of a point not on the line, find lines through that point that are parallel and perpendicular to the given line, symbolically and graphically.

Item Specifications

· Vocabulary allowed in items: vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

А	Slope is correct, but this line does not go through the point $(3, -1)$.
В	Correct. Found opposite reciprocal of slope, $-\frac{4}{3}$, then used $y = mx + b$ to find <i>v</i> -intercept.
С	Used reciprocal of slope, but did not use the opposite sign.
D	Used reciprocal of slope, but did not use the opposite sign.

Notes on grade expectations: Student should know from previous grades that perpendicular lines have opposite reciprocal slopes.



Benchmark: 8.4.1.2

Use a line of best fit to make statements about approximate rate of change and to make predictions about values not in the original data set.

For example: Given a scatterplot relating student heights to shoe sizes, predict the shoe size of a **5'**4" student, even if the data does not contain information for a student of that height.

Item Specifications

 Vocabulary allowed in items: scatterplot, line of best fit, and vocabulary given at previous grades

DOK: 2 Calculator: CL Answer: B

А	The scatterplot does not list all Ferris wheels; this statement cannot be confirmed.
В	Correct. Slope of line confirms 25 m per 10 years or 2.5 m/yr.
С	Only some, not all, of the newer Ferris wheels were taller.
D	The number of data points per year does not perpetually increase.

Notes on grade expectations: Student should be able to interpret a scatterplot and the line of best fit in terms of the context.

Consider the equation xy = z when x > 0 and y > 0. Which statements about the variables x, y, and z are true?
Select the statements you want to choose.
As x decreases, y decreases.
As x increases and y decreases, z does not change.
As z increases, both x and y increase.
As z does not change, x and y do not change.
As x and y both increase, z increases.
As x increases and y does not change, z increases.
As x increases, x increases.

Benchmark: 8.2.1.2

Use linear functions to represent relationships in which changing the input variable by some amount leads to a change in the output variable that is a constant times that amount.

For example: Uncle Jim gave Emily \$50 on the day she was born and \$25 on each birthday after that. The function f(x) = 50 + 25x represents the amount of money Jim has given after x years. The rate of change is \$25 per year.

Item Specifications

• Vocabulary allowed in items: independent, dependent, constant, coefficient, and vocabulary given at previous grades

DOK: 3 Calculator: CL Answer:

This is a technology-enhanced item. The correct answer is shown. A student must check both boxes in order to receive 1 point.

```
Consider the equation xy = z when x > 0 and y > 0. Which statements about the variables x, y, and z are true?
Select the statements you want to choose.
As x decreases, y decreases.
As x increases and y decreases, z does not change.
As z increases, both x and y increase.
As z does not change, x and y do not change.
As x and y both increase, z increases.
As x increases and y does not change, z increases.
As x increases, x increases.
```

Notes on grade expectations: Students may recall generic rules about working with negative numbers and numbers between 0 and 1, but in this item they must determine what rule to apply. The item uses only variables and therefore does not supply cueing for the student.



Benchmark: 8.2.4.5

Solve linear inequalities using properties of inequalities. Graph the solutions on a number line.

For example: The inequality -3x < 6 is equivalent to x > -2, which can be represented on the number line by shading in the interval to the right of -2.

Item Specifications

• Vocabulary allowed in items: vocabulary given at previous grades

DOK: 3 Calculator: CL Answer:

This is a technology-enhanced item. The correct answer is shown. A student must correctly graph the entire solution set in order to receive 1 point.

Solve.

|x| > 4

Graph the solution on the number line.

Select the type of solution. Drag the endpoints to the correct position.

