OKLAHOMA SCHOOL TESTING PROGRAM
OKLAHOMA CORE CURRICULUM TESTS

TEST AND ITEM SPECIFICATIONS

End-of-Instruction
ACE Algebra II

Oklahoma State Department of Education
Oklahoma City, Oklahoma

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OKLAHOMA CORE CURRICULUM TESTS

TEST AND ITEM SPECIFICATIONS

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Oklahoma School Testing Program
Test and Item Specifications
ACE Algebra II End-of-Instruction

Purpose

The purpose of this test is to measure Oklahoma students' level of proficiency at the End-of-Instruction in Algebra II. On the ACE Algebra II End-of-Instruction (EOI) test, students are required to respond to a variety of items linked to the Algebra II content standards identified in the Oklahoma Academic Standards (OAS). Each Algebra II test form will test each identified content standard and objective listed below. The following content standards and objectives are intended to summarize the knowledge as identified in the Oklahoma Academic Standards.

Oklahoma Academic Standards Algebra II Content Standards and Objectives
Number Sense and Algebraic Operations • Rational Exponents (1.1) • Polynomial and Rational Expressions (1.2) • Complex Numbers (1.3)
Relations and Functions • Functions and Function Notation (2.1) • Systems of Equations (2.2) • Quadratic Equations and Functions (2.3) • Conic Sections (2.4) • Exponential and Logarithmic Functions (2.5) • Polynomial Equations and Functions (2.6) • Rational Equations and Functions (2.7)
Data Analysis, Probability, and Statistics • Analysis of Collected Data (3.1) • Arithmetic and Geometric Sequences (3.3)

Note: All references to Oklahoma Academic Standards (OAS) indicate the content standards and objectives previously known as Priority Academic Student Skills (PASS).

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Test Structure, Format, and Scoring

The test will consist of 55 operational multiple-choice items and 10 field-test items, written at a reading level about three grade levels below an ACE Algebra II End-of- Instruction audience, and includes four responses from which to choose: the correct answer and three distractors. The total 65 items will be divided into two test sections.

Each multiple-choice item is scored as correct or incorrect. Only operational multiple- choice items contribute to the total test score. Thus, for example, if a test contains 55 operational items, only those 55 items (not the 10 field test) contribute to a student's scaled score on the test.

The student's raw score is converted to a scaled score using the number correct scoring method.

Test Alignment with Oklahoma Academic Standards

Criteria for Aligning the Test with the OAS Standards and Objectives
1. Categorical Concurrence The test is constructed so that there are at least six items measuring each OAS standard. The number of items, six, is based on estimating the number of items that could produce a reasonably reliable estimate of a student's mastery of the content measured.
2. Range-of-Knowledge Correspondence The test is constructed so that at least 75 percent of the objectives for an OAS standard have at least one corresponding assessment item.
3. Balance of Representation* The test construction shall yield a balance of representation with an index value of 0.7 or higher of assessed objectives related to a standard.
4. Source of Challenge Each test item is constructed in such a way that the major cognitive demand comes directly from the targeted OAS standard or objective being assessed, not from specialized knowledge or cultural background that the test-taker may bring to the testing situation.

* When new OAS standards and objectives are implemented, there is a transition period before the criteria for test alignment with OAS can be completely met. During this transition time, items are developed and field tested in order to meet the criteria for alignment to the OAS standards and objectives.

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Oklahoma School Testing Program

ACE Algebra II EOI – Test Blueprint
School Years 2014-2015, 2015-2016, 2016-2017

The blueprint describes the content and structure of an assessment and defines the ideal number of test items by standard and objective of the Priority Academic Student Skills/ Oklahoma Academic Standards (PASS/OAS).

Standards and Objectives	Ideal Number of Items	Ideal Percentage of Items
1.0 Number Sense and Algebraic Operations	**15**	**27%**
1.1 Rational Exponents	5 - 6	
1.2 Polynomial and Rational Expressions	5 - 6	
1.3 Complex Numbers	4	
2.0 Relations and Functions	**31**	**56%**
2.1 Functions and Function Notation	5	
2.2 Systems of Equations	5	
2.3 Quadratic Equations and Functions	5	
2.4 Conic Sections	4	
2.5 Exponential and Logarithmic Functions	4	
2.6 Polynomial Equations and Functions	4	
2.7 Rational Equations and Functions	4	
3.0 Data Analysis, Probability, & Statistics	**9**	**16%**
3.1 Analysis of Collected Data	5	
3.3 Arithmetic and Geometric Sequences	4	
Total Test	**55**	**100%**

(Please note this blueprint does not include items that may be field-tested.)

- A minimum of 6 items is required to report a standard, and a minimum of 4 items is required to report results for an objective.
- Percentages are approximations and may result in a sum other than 100 due to rounding.

Depth-of-Knowledge Assessed by Test Items

The test will approximately reflect the following "Depth-of-Knowledge" distribution of items:[1]

Depth-of-Knowledge	Percent of Items
Level 1—Recall and Reproduction	10–15%
Level 2—Skills and Concepts	60–70%
Level 3—Strategic Thinking	15–25%

Level 1 (Recall and Reproduction) requires the student to recall facts, terms, definitions, or simple procedures, perform algorithms, or apply formulas. One-step, well- defined, or straight algorithmic procedures should be included at this level.

Level 2 (Skills and Concepts) requires the student to make some decisions as to how to approach the problem or activity 2 activities include making observations and collecting data; classifying, comparing, and organizing data; and organizing and displaying data in tables, charts, and graphs.

Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking. Level 3 activit include making conjectures, drawing conclusions from observations, citing evidence and developing a logical argument for concepts, explaining phenomena in terms of concepts, and using concepts to solve nonroutine problems.

Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking most likely requiring an extended amount of time. The cognitive demands of the item should be high and the work should be very complex. Students are required to make several connections (relate ideas *within* the content area or among content areas) and have to select one approach among many alternatives on how the situation should be solved in order to be at this highest level.

Note: These descriptions are adapted from Review Background Information and Instructions, Standards and Assessment Alignment Analysis, CCSSO TILSA Alignment Study, May 21–24, 2001, Version 2.0.

For an extended description of each depth-of-knowledge level, see the web site at

http://facstaff.wcer.wisc.edu/normw/TILSA/INFO%20and%20INSTR%20Align%20Anal%20513.pdf

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[1]This is the ideal depth-of-knowledge distribution of items. There may be slight differences in the actual distribution of the upcoming testing session.

Universal Test Design Considerations

Universal design, as applied to assessments, is a concept that allows the widest possible range of students to participate in assessments and may even reduce the need for accommodations and alternative assessments by expanding access to the tests themselves. In the Oklahoma End-of-Instruction tests, modifications have been made to some items that simplify and clarify instructions, and provide maximum readability, comprehensibility, and legibility. This includes such things as reducing the language load in content areas other than Language Arts, increasing the font size, displaying fewer items per page, and boxing the items to assist visual focus. These modifications are evident in the sample items included in this document.

Multiple-Choice Item Guidelines

- All items must clearly indicate what is expected in a response and direct students to focus on their responses.
- Each multiple-choice item has a stem (question, statement, and/or graphic component) and four answer options, only one of which is correct.
- Multiple-choice item stems present a complete problem so that students will know what to do before looking at the answer choices. Students should not need to read all answer choices before knowing what is expected.
- In summary, End-of-Instruction ACE Algebra II test items assess whether students understand algebraic concepts and procedures, whether they can communicate their understandings effectively in mathematical terms, and whether they can approach problems and develop viable solutions.

Testing Schedule

Each End-of-Instruction test is meant to be administered in two sections within one day or consecutive days with the exception of English II and ACE English III, which will be administered in three sections over two or three days. Estimated time for scheduling purposes is given in the table below.

ACE Algebra II Online Test Time Schedule	
Distributing login information Section 1: Test instructions/tutorial and reviewing sample items Total:	Approximately 5 minutes Approximately 15 minutes Approximately 20 minutes
Administering Section 2 of the ACE Algebra II Online Test Total:	Approximately 60 minutes Approximately 60 minutes
Distributing login information Administering Section 3 of the ACE Algebra II Online Test Total:	Approximately 5 minutes Approximately 60 minutes Approximately 65 minutes

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Item Types

Each multiple-choice item has four responses—the correct answer and three distractors. Distractors are developed based on the types of errors students are most likely to make.

For item review committee purposes, information regarding the OAS and objectives addressed, item format, and correct answer key accompany each item.

Each item begins with a stem that asks a question or poses a clear problem. A stem will seldom include an incomplete sentence.

Most stems are positively worded—avoiding the use of the word "not." If a negative is required, it is underlined for emphasis (e.g., if a bag has the same number of red, blue, and black marbles, what is the probability that a marble randomly selected from the bag is <u>not</u> red?).

A stimulus that gives information precedes a question or a set of questions.

Stimulus Materials

Stimulus materials are the passages, graphs, models, figures, etc., that students must read and examine in order to respond to items. The following characteristics are necessary for stimulus materials:

1. When students are given information to evaluate, they should know the question and the purpose of the information.
2. Passages, graphics, tables, etc., provide sufficient information for assessment of multiple objectives.
3. Stimulus materials for a set of items may be a combination of multiple stimuli.
4. Information in stimulus materials is based on situations students would encounter in or beyond school.
5. For conceptual items, stimulus materials are necessary but not conceptually sufficient for student response.
6. There is a balance of graphic and textual stimulus materials within a test form. Approximately 50 percent of the items will have appropriate pictorial or graphical representations. Graphs, tables, or figures are clearly associated with their intended items. Graphics appear either on the same page as the stimulus or on the facing page.

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Online Administration

Test questions will be presented one at a time.

Answers may be selected by using either the mouse or the keyboard.

Navigation buttons appear at the end of the page for each question. For longer items, a scroll bar will appear on the right-hand side of the window to allow scrolling through answer choices.

Tools (including a scientific calculator on the ACE Algebra I and ACE Geometry assessments and a graphing calculator for the ACE Algebra II assessment) appear at the top of the screen/page to aid in answering questions.

Students will be able to use scratch paper for all online multiple choice assessments. This paper must be taken up and destroyed by the test administrator immediately following the test. The test administrator must not look at what the student has written on the scratch paper.

The stimulus and question will appear on the screen at the same time.

Item Specifications

It is necessary to create test items that are reliable, fair, and targeted to the OAS listed on the following pages. There are some general considerations and procedures for effective item development. These considerations include, but are not limited to, the following:

1. Each test form contains items assessing all content standards.
2. Test items that assess each standard are not limited to one particular type of response format.
3. Test questions attempt to focus on content that is authentic and that End-of- Instruction level students can relate to and understand.
4. Test items are worded precisely and clearly. The better focused an item, the more reliable and fair it is likely to be, and the more likely all students will understand what is required of them.
5. All items are reviewed to eliminate language that shows bias or that would otherwise likely disadvantage a particular group of students. That is, items do not display unfair representations of gender, race, ethnicity, disability, culture, or religion; nor do items contain elements that are offensive to any such groups.
6. Items are written so that calculations are kept to a minimum, and numbers are selected to minimize the time spent on computations.
7. All test items and answer choices have appropriate labels and units.
8. Most graphs are placed on a gray grid, with the x- and y-axes labeled and marked.
9. All multiple-choice answer choices—keys and distractors—are similar in length, syntax, or magnitude or have two sets of parallel answer choices (e.g., two short and two long). Students should not be able to rule out a wrong answer or identify a correct response solely by its appearance. Distractors are created so that students reason their way to the correct answer rather than simply identify incorrect responses because of a distractor's obviously inappropriate nature. Distractors should always be plausible (but incorrect) in the context of the item stem. Correct responses will be approximately equally distributed among answer choices.

All items developed using these specifications are reviewed annually by Oklahoma educators and approved by the Oklahoma State Department of Education. The distribution of newly developed items is based on difficulty, cognitive ability, percentage of art/graphics, and grade-level appropriateness as determined by an annual Item Development Plan approved by the Oklahoma State Department of Education.

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General Considerations—Oklahoma Core Curriculum Tests

1. Items deal with issues and details that are of consequence in the stimulus and central to students' understanding and interpretation of the stimulus.
2. Test items are varied and address all OAS standards and objectives listed in the ACE Algebra II EOI Test Blueprint.
3. To the greatest extent possible, no item or response choice clues the answer to other items.
4. All items reviewed and approved by the Oklahoma Item Review Committee are assigned an OAS standard and/or objective. The Test Blueprints and score reports reflect the degree to which each OAS standard and/or objective is represented on the test.
5. Test items are tied closely and particularly to the stimuli from which they are derived, so that the impact of outside (prior) knowledge, while never wholly avoidable, is minimized.
6. Each multiple-choice item contains a question and four answer options, only one of which is correct. Correct answers are approximately equally distributed among A's, B's, C's, and D's.
7. The four choices are approximately the same length, have the same format, and are syntactically and semantically parallel; students should not be able to rule out a wrong answer or identify a correct response solely because it looks different from the other answer choices.
8. Distractors adopt the language and sense of the material in the stimuli so that students think their way to the correct answer rather than simply identify incorrect responses by virtue of a distractor's obviously inappropriate nature.
9. Distractors should always be plausible (but, of course, incorrect) in the context of the stimulus.
10. Order of presentation of item types is dictated by logic (chronologically, spatially, etc.).
11. Items are worded precisely and clearly. The better focused an item, the more reliable and fair it is certain to be, and the more likely all students will understand it in the same way.
12. It is not possible to measure every OAS objective on the test. However, at least 75% of the objectives from each OAS are included on the test.
13. The range of items measuring an OAS objective consisting of more than one skill will provide a balanced representation of those skills.
14. Items should be focused on what all students should know and be able to do as they complete their End-of-Instruction coursework.
15. The responses "Both of the above," "All of the above," "None of the above," and "Neither of the above" will not be used.
16. The material presented is balanced, culturally diverse, well written, and of interest to End-of-Instruction level students. The stimuli and items are fairly presented in order to gain a true picture of students' skills.
17. Across all forms, a balance of gender and active/passive roles by gender is maintained.
18. Forms attempt to represent the ethnic diversity of Oklahoma students.
19. Approved calculators may be used on specified sections of the ACE Algebra II EOI. No other resource materials may be used by students during the test.
20. The stimuli avoid subject matter that might prompt emotional distress on the part of the students.
21. In addition to the 55 operational items, there will be 10 field test items per form.
22. Permission to use stimuli from copyrighted material is obtained as necessary by the testing vendor.

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OVERVIEW OF ITEM SPECIFICATIONS

For each OAS Standard, item specifications are organized under the following headings:

- OAS Standard
- OAS Objective (and Skills)
- Item Specifications
    a. Emphasis
    b. Stimulus Attributes
    c. Format
    d. Content Limits
    e. Primary Process Standard(s)
    f. Distractor Domain
    g. Sample Test Items

The headings "OAS Standard" and "OAS Objective" state the OAS Standard followed by the OAS Objective being measured in the mathematics section of the Oklahoma Academic document.

For each objective, the information under the heading "Item Specifications" highlights important points about a test item's emphasis, stimulus attributes, format, content limits, primary Process Standards, and distractor domain. Sample test items are also included with each objective to illustrate these specifications. Although it is sometimes possible to score single items for more than one concept, all items in these tests are written to address a single content standard as the primary concept.

Note: With the exception of content limits, the Item Specifications offer suggestions of what might be included and do not provide an exhaustive list of what can be included.

In addition, the sample test items are not intended to be definitive in nature or construction—the stimuli and the test items that follow them may differ from test form to test form, as may their presentations.

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MATHEMATICS CONTENT STANDARDS

Algebra II

The following skills are required of all students completing Algebra II. **Major Concepts** should be taught in depth using a variety of methods and applications (concrete to the abstract). **Maintenance Concepts** have been taught previously and are a necessary foundation for this course. The major concepts are considered minimal exit skills, and districts are strongly encouraged to exceed these skills when building an Algebra II curriculum. Visual and physical models, calculators, and other technologies are recommended when appropriate and can enhance both instruction and assessment.

MAJOR CONCEPTS

Number Systems and Algebraic Operations—Real and Complex Numbers

Relations and Functions—Quadratic, Polynomial, Exponential, Logarithmic, Rational

Data Analysis and Statistics—Probability Relationships, Measures of Central Tendency and Variability, Sequences and Series

MAINTENANCE CONCEPTS

Number Systems and Algebraic Operations - Polynomials and Exponents

Relations and Functions - Expressions and Slope

Data Analysis and Statistics - Data Displays

Geometry - Basic Geometric Formulas

Standard 1: Number Systems and Algebraic Operations—The student will perform operations with rational, radical, and polynomial expressions, as well as expressions involving complex numbers.

1. Rational Exponents
   a. Convert expressions from radical notations to rational exponents and vice versa.
   b. Add, subtract, multiply, divide, and simplify radical expressions and expressions containing rational exponents.
2. Polynomial and Rational Expressions
   a. Divide polynomial expressions by lower degree polynomials.
   b. Add, subtract, multiply, divide, and simplify rational expressions, including complex fractions.

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3. Complex Numbers

   *a. Recognize that to solve certain problems and equations, number systems need to be extended from real numbers to complex numbers.

   b. Add, subtract, multiply, divide, and simplify expressions involving complex numbers.

Standard 2: Relations and Functions—The student will use the relationships among the solution of an equation, zero of a function, *x*-intercepts of a graph, and factors of a polynomial expression to solve problems involving relations and functions.

1. Functions and Function Notation

   a. Recognize the parent graphs of polynomial, exponential, radical, quadratic, and logarithmic functions and predict the effects of transformations on the parent graphs, using various methods and tools which may include graphing calculators.

   b. Add, subtract, multiply, and divide functions using function notation.

   c. Combine functions by composition.

   d. Use algebraic, interval, and set notations to specify the domain and range of functions of various types.

   e. Find and graph the inverse of a function, if it exists.

2. Systems of Equations

   a. Model a situation that can be described by a system of equations or inequalities, and use the model to answer questions about the situation.

   b. Solve systems of linear equations and inequalities using various methods and tools which may include substitution, elimination, matrices, graphing, and graphing calculators.

   *c. Use either one quadratic equation and one linear equation or two quadratic equations to solve problems.

3. Quadratic Equations and Functions

   a. Solve quadratic equations by graphing, factoring, completing the square, and quadratic formula.

   b. Graph a quadratic function and identify the *x*- and *y*-intercepts and maximum or minimum value, using various methods and tools which may include a graphing calculator.

   c. Model a situation that can be described by a quadratic function, and use the model to answer questions about the situation.

Note: Asterisks (*) have been used to identify standards and objectives that must be assessed by the local school district. All other skills may be assessed by the Oklahoma School Testing Program (OSTP).

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4. Identify, graph, and write the equations of the conic sections (circle, ellipse, parabola, and hyperbola).
5. Exponential and Logarithmic Functions
   a. Graph exponential and logarithmic functions.
   b. Apply the inverse relationship between exponential and logarithmic functions to convert from one form to another.
   c. Model a situation that can be described by an exponential or logarithmic function, and use the model to answer questions about the situation.
6. Polynomial Equations and Functions
   a. Solve polynomial equations using various methods and tools which may include factoring and synthetic division.
   b. Sketch the graph of a polynomial function.
   c. Given the graph of a polynomial function, identify the x- and y-intercepts, relative maximums and relative minimums, using various methods and tools which may include a graphing calculator.
   d. Model a situation that can be described by a polynomial function, and use the model to answer questions about the situation.
7. Rational Equations and Functions
   a. Solve rational equations.
   b. Sketch the graph of a rational function.
   c. Given the graph of a rational function, identify the x- and y-intercepts, vertical asymptotes, using various methods and tools which may include a graphing calculator.
   d. Model a situation that can be described by a rational function, and use the model to answer questions about the situation.

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Standard 3: Data Analysis and Statistics—The student will use data analysis and statistics to formulate and justify predictions from a set of data.

1. Analysis of Collected Data Involving Two Variables
   a. Interpret data on a scatter plot using a linear, exponential, or quadratic model/equation.
   b. Identify whether the model/equation is a curve of best fit for the data, using various methods and tools which may include a graphing calculator.

*2. Measures of Central Tendency and Variability
   a. Analyze and synthesize data from a sample, using appropriate measures of central tendency (mean, median, mode, weighted average).
   b. Analyze and synthesize data from a sample, using appropriate measures of variability (range, variance, standard deviation).
   c. Use the characteristics of the Gaussian normal distribution (bell-shaped curve) to solve problems.
   d. Identify how given outliers affect representations of data.

3. Identify and use arithmetic and geometric sequences and series to solve problems.

Note: Asterisks (*) have been used to identify standards and objectives that must be assessed by the local school district. All other skills may be assessed by the Oklahoma School Testing Program (OSTP).

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PROCESS STANDARDS

High School

The National Council of Teachers of Mathematics (NCTM) has identified five process standards: Problem Solving, Reasoning and Proof, Communication, Connections, and Representation. Active involvement by students using these processes is likely to broaden mathematical understandings and lead to increasingly sophisticated abilities required to meet mathematical challenges in meaningful ways.

Standard 1: Problem Solving

1. Apply a wide variety of problem-solving strategies (identify a pattern, use equivalent representations) to solve problems from within and outside mathematics.
2. Identify the problem from a described situation, determine the necessary data and apply appropriate problem-solving strategies.

Standard 2: Communication

1. Use mathematical language and symbols to read and write mathematics and to converse with others.
2. Demonstrate mathematical ideas orally and in writing.
3. Analyze mathematical definitions and discover generalizations through investigations.

Standard 3: Reasoning

1. Use various types of logical reasoning in mathematical contexts and real-world situations.
2. Prepare and evaluate suppositions and arguments.
3. Verify conclusions, identify counterexamples, test conjectures, and justify solutions to mathematical problems.
4. Justify mathematical statements through proofs.

Standard 4: Connections

1. Link mathematical ideas to the real world (e.g., statistics helps qualify the confidence we can have when drawing conclusions based on a sample).
2. Apply mathematical problem-solving skills to other disciplines.
3. Use mathematics to solve problems encountered in daily life.
4. Relate one area of mathematics to another and to the integrated whole (e.g., connect equivalent representations to corresponding problem situations or mathematical concepts).

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Standard 5: Representation

1. Use algebraic, graphic, and numeric representations to model and interpret mathematical and real-world situations.
2. Use a variety of mathematical representations as tools for organizing, recording, and communicating mathematical ideas (e.g., mathematical models, tables, graphs, spreadsheets).
3. Develop a variety of mathematical representations that can be used flexibly and appropriately.

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OAS: Standard

Standard 1: Number Sense and Algebraic Operations

OAS Objective:

Objective 1.1: Rational Exponents

OAS Skill:

Skill 1.1a: Convert expressions from radical notations to rational exponents and vice versa.

Item Specifications:

Emphasis:

- The student will perform conversion operations between rational and radical expressions.

Stimulus Attributes:

- Test items may include rational and radical expressions.

Format:

- Convert a rational to a radical expression.
- Convert a radical to a rational expression.

Content Limits:

- Limit to real rational and radical expressions with no imaginary expressions.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect exponent operations
- Incorrect roots of radicals

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Sample Test Items for Skill 1.1a

Depth-of-Knowledge: 1

Which is equivalent to $15^{-\frac{2}{3}}$?

A $\frac{1}{\sqrt[3]{15^2}}$

B $\frac{1}{\sqrt[2]{15^3}}$

C $-\sqrt[3]{15^2}$

D $-\sqrt[2]{15^3}$

Correct Response: **A**

Depth-of-Knowledge: 1

Which expression is another way to write $\sqrt[4]{5x^3}$?

A $5^{\frac{1}{4}}x^{\frac{3}{4}}$

B $5^{\frac{4}{1}}x^{\frac{4}{3}}$

C $5^{\frac{3}{4}}x^{\frac{3}{4}}$

D $5^{\frac{4}{3}}x^{\frac{4}{3}}$

Correct Response: **A**

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OAS:

Standard 1: Number Sense and Algebraic Operations

Oklahoma Academic Objective:

Objective 1.1: Rational Exponents

Oklahoma Academic Skill:

Skill 1.1b: Add, subtract, multiply, divide, and simplify radical expressions and expressions containing rational exponents.

Item Specifications:

Emphasis:

- The student will perform operations with rational and radical expressions.

Stimulus Attributes:

- Test items may include rational and radical expressions.

Format:

- Add, subtract, multiply, divide, and/or simplify rational and/or radical expressions.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and equations.

Content Limits:

- Limit to rational and radical expressions with no imaginary expressions.
- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect exponent operations
- Incorrect roots of radicals

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Sample Test Items for Skill 1.1b

Depth-of-Knowledge: 1

What is the simplified expression of $\sqrt{\frac{36x^8}{4x^6}}$?

A $3|x|$

B $9|x|$

C $3x^2$

D $9x^2$

Correct Response: **A**

Depth-of-Knowledge: 2

What is the simplified form of $(2\sqrt{5} + 3)(\sqrt{5} - 1)$?

A $\sqrt{5} - 3$

B $\sqrt{5} + 7$

C $2\sqrt{5} - 3$

D $2\sqrt{5} + 7$

Correct Response: **B**

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Depth-of-Knowledge: 2

If x and y are positive real numbers, which expression is equivalent to $(16x^5y^8)^{\frac{1}{2}}$?

A $8x^3y^6$

B $4x^3y^6$

C $8x^{\frac{5}{2}}y^4$

D $4x^{\frac{5}{2}}y^4$

Correct Response: **D**

Depth-of-Knowledge: 2

What is the sum of $\frac{1}{3\sqrt{25}}$ and $\frac{1}{2\sqrt[3]{27}}$?

A $\frac{2}{21}$

B $\frac{7}{30}$

C $\frac{2}{33}$

D $\frac{11}{90}$

Correct Response: **B**

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Depth-of-Knowledge: 3

Which expression is equivalent to $(5 - \sqrt{2})^3$?

A $155 - 77\sqrt{2}$

B $125 - 2\sqrt{2}$

C $27 - 10\sqrt{2}$

D $15 - 3\sqrt{2}$

Correct Response: **A**

Depth-of-Knowledge: 3

The area of a square is $2\sqrt{2} + 3$. What is the length of a side of the square?

A $\sqrt{2} - 1$

B $\sqrt{2} + 1$

C $2\sqrt{2} - 1$

D $2\sqrt{2} + 1$

Correct Response: **B**

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OAS:

Standard 1: Number Sense and Algebraic Operations

Oklahoma Academic Objective:

Objective 1.2: Polynomial and Rational Expressions

Oklahoma Academic Skill:

Skill 1.2a: Divide polynomial expressions by lower degree polynomials.

Item Specifications:

Emphasis:

- The student may perform operations with polynomial expressions.
- The student may apply basic geometric formulas for area, perimeter, and volume.

Stimulus Attributes:

- Test items may include polynomial expressions.

Format:

- Identify and perform correct division procedures, including factoring, synthetic division, and long division, on polynomial expressions.

Content Limits:

- Limit items to those that do not require a specific procedure.
- Limit to polynomials with no imaginary expressions.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect exponent operations
- Incorrect roots of radicals
- Incorrect factors

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Sample Test Items for Skill 1.2a

Depth-of-Knowledge: 1

$$\frac{8x^6z^4 + 4x^4z^2}{4x^2z}$$

Which expression represents the quotient?

A $2x^4z^3 + x^2z$

B $2x^3z^4 + x^2z^2$

C $4x^4z^3 + 3x^2z$

D $4x^3z^4 + 3x^2z^2$

Correct Response: **A**

Depth-of-Knowledge: 2

$$(y^2 - 4y - 32) \div (y + 4)$$

Which expression represents the quotient?

A $y - 8$

B $y + 8$

C $y - 4$

D $y + 4$

Correct Response: **A**

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Depth-of-Knowledge: 3

A rectangular prism has a volume of $8x^3 + 14x^2 + x - 2$ and a height of $2x + 1$. Which expression represents the area of the base of the prism?

$V = Bh$

A $4x^2 + 5x - 2$

B $4x^2 + 5x + 2$

C $4x^2 + 9x + 4$

D $4x^2 + 9x + 5$

Correct Response: **A**

Depth-of-Knowledge: 3

What is $(3x^5 - 15x^4 + 4x^3 + 11x^2 - 9x + 2)$ divided by $(x^2 - 5x + 2)$?

A $3x^3 - 2x + 1$

B $3x^3 - 2x^2 + 7$

C $3x^3 - 2x^2 + 7x + 26$

D $3x^3 - 30x^2 + 160x - 849$

Correct Response: **A**

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OAS:

Standard 1: Number Sense and Algebraic Operations

Oklahoma Academic Objective:

Objective 1.2: Polynomial and Rational Expressions

Oklahoma Academic Skill:

Skill 1.2b: Add, subtract, multiply, divide, and simplify rational expressions, including complex fractions.

Item Specifications:

Emphasis:

- The student may perform operations with rational expressions and complex fractions.
- The student may apply basic geometric formulas for area and perimeter.

Stimulus Attributes:

- Test items may include rational expressions and complex fractions.

Format:

- Identify simplified algebraic equivalents of rational expressions and complex fractions.

Content Limits:

- Limit to rational expressions and complex fractions with no imaginary expressions.
- Limit to basic geometry formulas; that is, no volume formulas.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect exponent operations
- Incorrect roots of radicals
- Incorrect factors
- Incorrect arithmetic operations

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Sample Test Items for Skill 1.2b

Depth-of-Knowledge: 1

Which expression is equivalent to $\frac{x^2 + x - 12}{x^2 - 6x + 9}$?

A $\frac{x-3}{x+4}$

B $\frac{x+4}{x-3}$

C $2x^2 - 5x - 3$

D $2x^2 + 7x + 21$

Correct Response: **B**

Depth-of-Knowledge: 2

$$\frac{4x^2y}{8xy^2} \div \frac{12xy^2}{8x^6y^3}$$

Which expression represents the quotient?

A $\frac{x^5}{3}$

B $\frac{3}{x^5}$

C $\frac{x^6}{3}$

D $\frac{3}{x^6}$

Correct Response: **C**

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Depth-of-Knowledge: 2

$$\frac{3x-1}{x+2}-\frac{x-2}{x-1}$$

Which expression represents the result of this subtraction?

A $\frac{2x+1}{3}$

B $\frac{2x+1}{x^2+x-2}$

C $\frac{3x^2-4x+5}{3}$

D $\frac{2x^2-4x+5}{x^2+x-2}$

Correct Response: **D**

Depth-of-Knowledge: 3

Which expression is equivalent to $2-x-\frac{1}{3-x}$?

A $\frac{1}{3-2x}$

B $\frac{x^2-x+3}{3-x}$

C $\frac{x^2-5x+5}{3-x}$

D $\frac{x^2-5x+7}{3-x}$

Correct Response: **C**

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OAS:

Standard 1: Number Sense and Algebraic Operations

Oklahoma Academic Objective:

Objective 1.3: Complex Numbers

Oklahoma Academic Skill:

Skill 1.3a* Recognize that to solve certain problems and equations, number systems need to be extended from real numbers to complex numbers.

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Note: Asterisks (*) have been used to identify standards and objectives that must be assessed by the local school district. All other skills may be assessed by the Oklahoma School Testing Program (OSTP).

OAS:

Standard 1: Number Sense and Algebraic Operations

Oklahoma Academic Objective:

Objective 1.3: Complex Numbers

Oklahoma Academic Skill:

Skill 1.3b: Add, subtract, multiply, divide, and simplify expressions involving complex numbers.

Item Specifications:

Emphasis:

- The student will perform operations with expressions involving complex numbers.

Stimulus Attributes:

- Test items may include expressions involving complex numbers.

Format:

- Identify simplified algebraic equivalents of expressions involving complex numbers.

Content Limits:

- Limit to no more than two distinct operations between complex numbers.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect use of i
- Incorrect exponent operations
- Incorrect arithmetic operations

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Sample Test Items for Skill 1.3b

Depth-of-Knowledge: 1

Which expression is equivalent to $(4i)^3$?

A $-12i$

B $12i$

C $-64i$

D $64i$

Correct Response: **C**

Depth-of-Knowledge: 2

A circuit has a current of $(8 + 7i)$ amps, and another circuit has a current of $(5 - 3i)$ amps. What is the difference between the currents of the two circuits?

A $(3 - 4i)$ amps

B $(3 + 4i)$ amps

C $(3 - 10i)$ amps

D $(3 + 10i)$ amps

Correct Response: **D**

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Depth-of-Knowledge: 2

Which expression is equivalent to $\sqrt{-6}\ (\sqrt{-4} - \sqrt{3}\ )$?

A $2\sqrt{6} + 3\sqrt{2}$

B $-24 - 6i\sqrt{3}$

C $2\sqrt{6} - 3i\sqrt{2}$

D $-2\sqrt{6} - 3i\sqrt{2}$

Correct Response: **D**

Depth-of-Knowledge: 2

What is the product of $(2 + 3i)$ and $(5 - 4i)$?

A $-2 - 23i$

B $-2 + 7i$

C $22 - 23i$

D $22 + 7i$

Correct Response: **D**

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Depth-of-Knowledge: 2

Which expression is equivalent to $\frac{2}{5+i}$?

A $\frac{5-i}{12}$

B $\frac{5+i}{12}$

C $\frac{5-i}{13}$

D $\frac{5+i}{13}$

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.1: Functions and Function Notation

Oklahoma Academic Skill:

Skill 2.1a: Recognize the parent graphs of polynomial, exponential, radical, quadratic, and logarithmic functions and predict the effects of transformations on the parent graphs, using various methods and tools which may include graphing calculators.

Item Specifications:

Emphasis:

- The student will use the relationships in equations and functions to solve problems involving parent graphs and transformations.

Stimulus Attributes:

- Test items may include parent graphs, equations, functions, and transformations.

Format:

- Identify parent graphs and effects of transformations.
- Identify equations and functions resulting from transformations.

Content Limits:

- Limit items to the use of no more than two transformations.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Interchange of x and y
- Miscalculation of direction

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Sample Test Items for Skill 2.1a

Depth-of-Knowledge: 2

$$y = (x - 3)^2$$

What is the parent graph of this function and what transformations have taken place on it?

A The parent graph is $y = x$, which is translated 3 units to the left.

B The parent graph is $y = x$, which is translated 3 units to the right.

C The parent graph is $y = x^2$, which is translated 3 units to the left.

D The parent graph is $y = x^2$, which is translated 3 units to the right.

Correct Response: **D**

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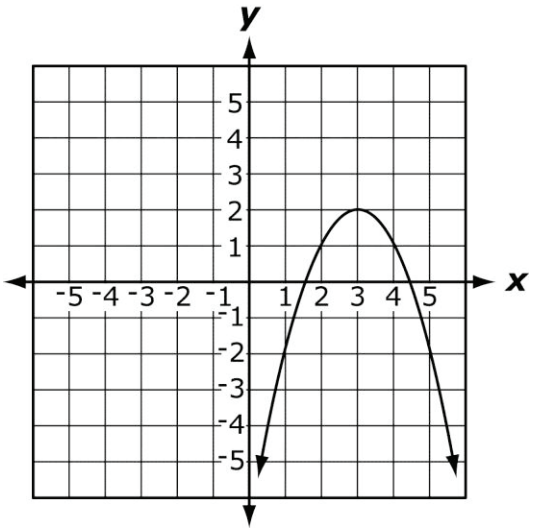
Depth-of-Knowledge: 2



What is the parent function of this graph?

A $f(x) = x^2$

B $f(x) = |x|$

C $f(x) = x$

D $f(x) = x^3$

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.1: Functions and Function Notation

Oklahoma Academic Skill:

Skill 2.1b: Add, subtract, multiply, and divide functions using function notation.

Item Specifications:

Emphasis:

- The student will use the relationships in function notation to solve problems.

Stimulus Attributes:

- Test items may include functions or graphs.

Format:

- Identify the result of operations with functions.
- Identify graphs given operations with functions.

Content Limits:

- Limit to the use of no more than two functions.
- Limit to polynomial functions.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Incorrect function operations

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Depth-of-Knowledge: 2

if $f(x) = 3x^2 - 2$ and $g(x)$ $4x + 2$, what is the value of $(f + g)(-1)$?

A -7

B -1

C 1

D 7

Correct Response: **B**

Depth-of-Knowledge:2

If $f(x) = x^2 - 1$ and $g(x) = x - 1$, which expression is equivalent to $\left(\frac{f}{g}\right)(x)$?

A $x - 1$

B $x + 1$

C $\frac{1}{x-1}$

D $\frac{1}{x+1}$

Correct Response: **B**

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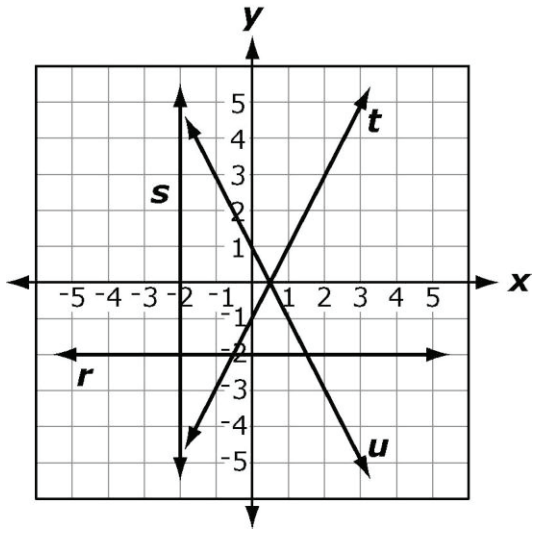
Depth-of-Knowledge: 3



If $f(x) = x - \frac{1}{2}$ and $g(x) = -2$, which graph corresponds to the function $(fg)(x)$?

A line *r*

B line *s*

C line *t*

D line *u*

Correct Response: **D**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.1: Functions and Function Notation

Oklahoma Academic Skill:

Skill 2.1c: Combine functions by composition.

Item Specifications:

Emphasis:

- The student will solve problems involving composition of functions.

Stimulus Attributes:

- Test items may include two functions and/or a composition.

Format:

- Identify the composition of two functions.
- Identify two functions given a composition.

Content Limits:

- Limit to the use of no more than two functions.
- Limit to polynomial functions.

Primary Process Standards:

- Problem Solving
- Reasoning
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of function composition

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Sample Test Items for Skill 2.1c

Depth-of-Knowledge: 2

If $f(x) = 2x + 5$ and $g(x) = 3x$, what is the value of $(f \circ g)(1)$?

A 8

B 10

C 11

D 17

Correct Response: **C**

Depth-of-Knowledge: 2

$$f(x) = 2x + 7$$

$$g(x) = 3x^2 - 1$$

Which expression represents $f(g(x))$?

A $6x^2 + 5$

B $6x^2 + 12$

C $3x^2 - 2x - 8$

D $3x^2 + 2x + 6$

Correct Response: **A**

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Depth-of-Knowledge: 3

If $(f \circ g)(x) = 2x - 1$, how might $f(x)$ and $g(x)$ be defined?

A $f(x) = (x - 1)$ and $g(x) = (2x - 1)$

B $f(x) = (x - 1)$ and $g(x) = (2x + 1)$

C $f(x) = (2x - 1)$ and $g(x) = (x - 1)$

D $f(x) = (2x + 1)$ and $g(x) = (x - 1)$

Correct Response: **D**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.1: Functions and Function Notation

Oklahoma Academic Skill:

Skill 2.1d: Use algebraic, interval, and set notations to specify the domain and range of functions of various types.

Item Specifications:

Emphasis:

- The student will use the proper notation to specify the domain and range of functions.

Stimulus Attributes:

- Test items may include linear, rational, polynomial, and radical functions.
- Test items may include the following types of notation:

Algebraic:	$x > 5$ and $x \neq 8$
	$0 \leq f(x) \leq \infty$
	$x \leq -3$ or $x \geq 7$
Set:	$\{x: x > 5 \text{ and } x \neq 8\}$
	$\{x \mid x = 7\}$
	$\{-3, 5, 8, 12\}$
Interval:	$[-2, 8]$
	$(-\infty, \infty)$
	$(-\infty, 4]$ and $[12, \infty)$

Format:

- Identify domain or range of a function.

Content Limits:

- Limit the denominator of rational functions to 1st or 2nd degree polynomials.

Primary Process Standards:

- Problem Solving
- Reasoning
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Interchange of domain and range
- Misconceptions of domain and range

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Sample Test Items for Skill 2.1d

Depth-of-Knowledge: 1

Which statement is <u>true</u> for the function $f(x) = \frac{1}{x+4}$?

A 4 is not in the range of the function.

B 4 is not in the domain of the function.

C –4 is not in the range of the function.

D –4 is not in the domain of the function.

Correct Response: **D**

Depth-of-Knowledge: 2

What is the domain of the function $f(x) = \frac{x+5}{x^2+2x-8}$?

A $\{x : x \neq 0\}$

B $\{x : x \neq -5\}$

C $\{x : x \neq -2, 4\}$

D $\{x : x \neq 2, -4\}$

Correct Response: **D**

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Depth-of-Knowledge: 2

What is the domain of the function $f(x) = \sqrt{4 - x}$?

A $\{x : x \geq 4\}$

B $\{x : x \leq 4\}$

C $\{x : x \geq -4\}$

D $\{x : x \leq -4\}$

Correct Response: **B**

Depth-of-Knowledge: 2

Which intervals correctly define the domain of $f(x) = \frac{1}{x+4} - 2$?

A $(-\infty, 4)$ and $(4, \infty)$

B $(-\infty, -4)$ and $(4, \infty)$

C $(-\infty, -4)$ and $(-4, \infty)$

D $(-\infty, -4)$ and $(-2, \infty)$

Correct Response: **C**

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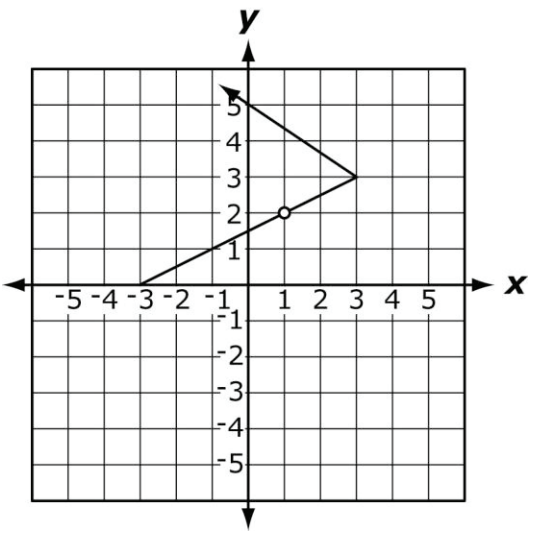
Depth-of-Knowledge: 3

Domain: $\{x \mid x \geq 0, x \neq 2\}$

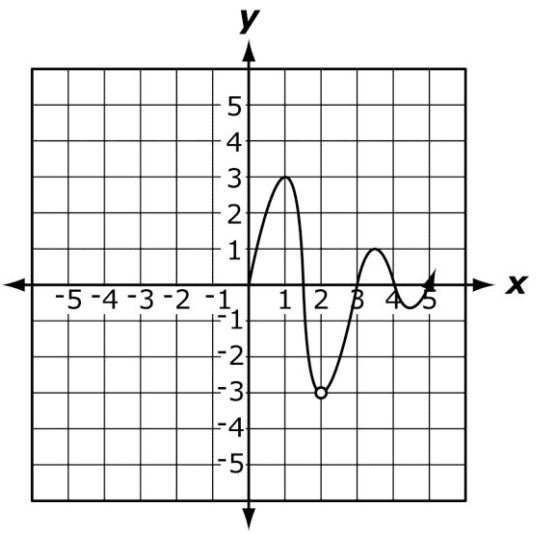
Range: $\{y \mid -3 < y \leq 3\}$

Which graph corresponds to the given constraints?

A



B



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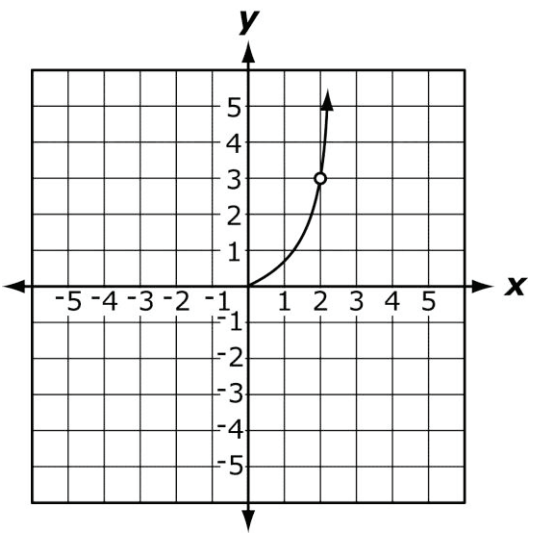
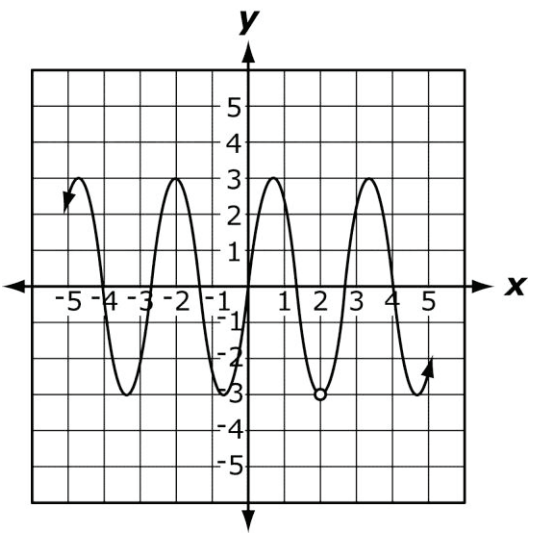


D



Correct Response: **B**

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Depth-of-Knowledge: 3

Which function has the fewest domain restrictions for real numbers?

A $f(x) = \dfrac{1}{x-1}$

B $f(x) = \dfrac{1}{x+1}$

C $f(x) = \dfrac{1}{x^2-1}$

D $f(x) = \dfrac{1}{x^2+1}$

Correct Response: **D**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.1: Functions and Function Notation

Oklahoma Academic Skill:

Skill 2.1e: Find and graph the inverse of a function, if it exists.

Item Specifications:

Emphasis:

- The student will determine the inverse of a function.

Stimulus Attributes:

- Test items may include functions or their inverse.

Format:

- Identify the inverse of a function.
- Identify the graph for the inverse of a function.

Content Limits:

- Limit functions to those including no more than three distinct operations.

Primary Process Standards:

- Problem Solving
- Reasoning
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Reciprocals
- Misconceptions of inverse functions

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Sample Test Items for Skill 2.1e

Depth-of-Knowledge: 1

What is the inverse of $f(x) = x + 1$?

A $f^{-1}(x) = {}^{-}x - 1$

B $f^{-1}(x) = x - 1$

C $f^{-1}(x) = \dfrac{{}^{-}1}{1 + x}$

D $f^{-1}(x) = \dfrac{1}{1 + x}$

Correct Response: B

Depth-of-Knowledge: 1

Which statement about graphs and their inverse is true?

A They are symmetric about $y = x$.

B They are symmetric about the origin.

C They are symmetric about the x-axis.

D They are symmetric about the y-axis.

Correct Response: **A**

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Depth-of-Knowledge: 2

$$f(x) = (x + 4)^2$$

Which function is the inverse of $f(x)$?

A $f^{-1}(x) = \sqrt{x} - 4$

B $f^{-1}(x) = \dfrac{1}{(x+4)^2}$

C $f^{-1}(x) = (x - 4)^2$

D $f^{-1}(x)$ *is not a function.*

Correct Response: **D**

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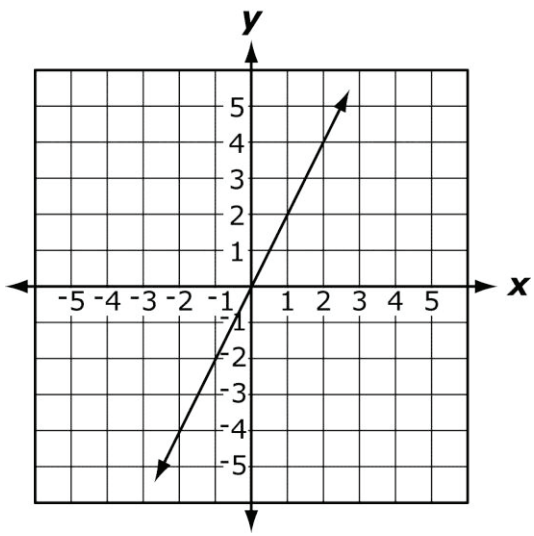
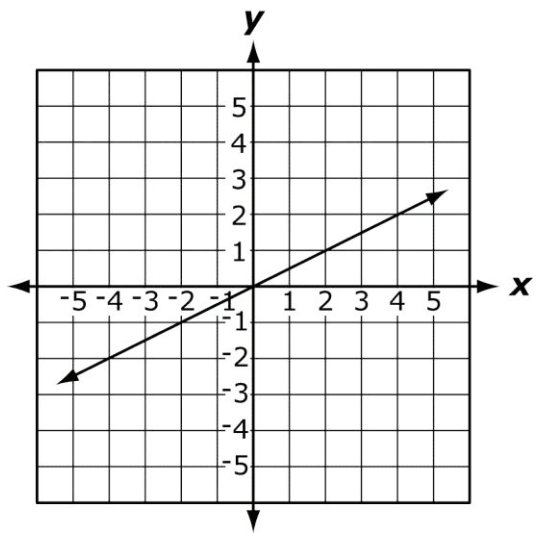
Depth-of-Knowledge: 2

Which graph represents the inverse of $f(x) = 2x$?

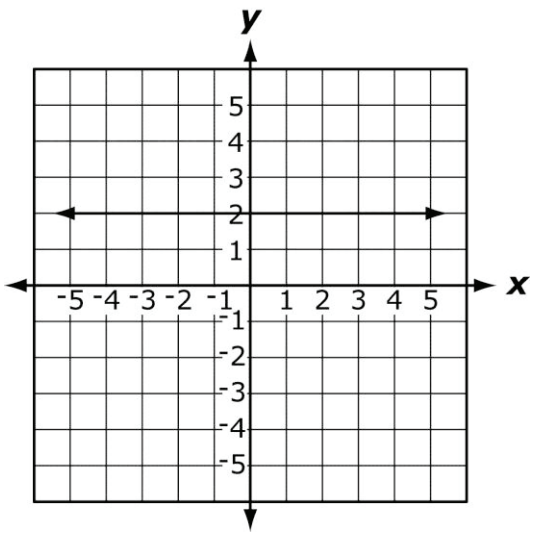
A



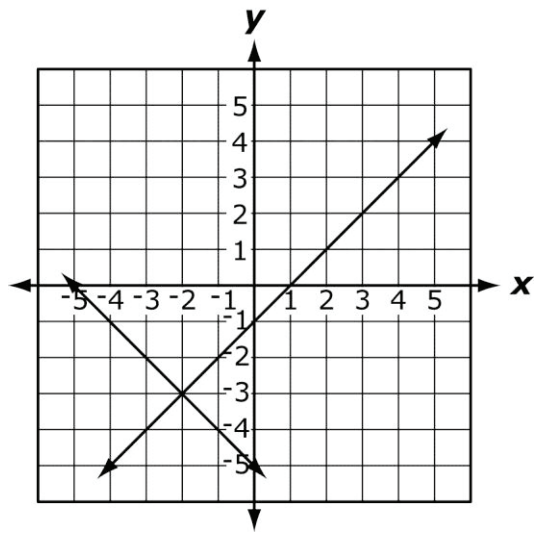
B



C



D



Correct Response: **B**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.2: Systems of Equations

Oklahoma Academic Skill:

Skill 2.2a: Model a situation that can be described by a system of equations or inequalities, and use the model to answer questions about the situation.

Item Specifications:

Emphasis:

- The student will model a situation using a system of equations or inequalities.

Stimulus Attributes:

- Test items may include equations, inequalities, functions, tables, graphs, charts, or diagrams.

Format:

- Identify systems of equations and inequalities that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by systems of equations and inequalities.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of formulating equations from context

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Sample Test Items for Skill 2.2a

Depth-of-Knowledge: 1

Profits, *P*, are equal to sales, *S*, minus expenses, *E*. If expenses are equal to travel, *T*, plus materials, *M*, which system of equations models this situation?

A $\begin{cases} P = S - E \\ E = T + M \end{cases}$

B $\begin{cases} P = S + E \\ E = T + M \end{cases}$

C $\begin{cases} P = S - E \\ E = T - M \end{cases}$

D $\begin{cases} P = S + E \\ E = T - M \end{cases}$

Correct Response: **A**

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Depth-of-Knowledge: 2

Tyrone spent no more than $1,500 to buy a television and a DVD player. He spent at least 4 times as much for the television as for the DVD player. The television and the DVD player each cost at least $100. Which system of inequalities models the amount of money Tyrone spent to buy the television, *T*, and the DVD player, *D*?

A $\begin{cases} T + D \geq 1{,}500 \\ T \geq 4D \\ T \geq 100 \\ D \geq 100 \end{cases}$

B $\begin{cases} 0 \leq T + D \leq 1{,}500 \\ D \geq 4T \\ T \geq 100 \\ D \geq 100 \end{cases}$

C $\begin{cases} 0 \leq T + D \leq 1{,}500 \\ T \geq 4D \\ T \geq 100 \\ D \geq 100 \end{cases}$

D $\begin{cases} T + D \geq 1{,}500 \\ D \geq 4T \\ T \geq 100 \\ D \geq 100 \end{cases}$

Correct Response: **C**

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Depth-of-Knowledge: 3

The vertices of a triangle are (2, 1), (4, 4), and (6, 2). Which system of inequalities describes the interior of the triangle?

A $\begin{cases} 4y > x + 2 \\ 3y < 2x - 1 \\ y < 8 - x \end{cases}$

B $\begin{cases} 4y > x + 2 \\ 2y < 3x - 4 \\ y < 8 - x \end{cases}$

C $\begin{cases} 2y > x \\ 2y < 3x - 4 \\ y < 8 - x \end{cases}$

D $\begin{cases} 2y > x \\ 3y < 2x - 1 \\ y < 8 - x \end{cases}$

Correct Response: **B**

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Depth-of-Knowledge: 3

Meredith invests $50,000 in her new business. It costs the company $10 to produce each unit, which is sold for $15. Let C represent the cost and R represent the revenue for x units. Which statement is <u>true</u> about the graphs of the equations $C = 50{,}000 + 10x$ and $R = 15x$?

A Both slopes are positive.

B Both slopes are negative.

C One slope is positive, and the other is zero.

D One slope is negative, and the other is positive.

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.2: Systems of Equations

Oklahoma Academic Skill:

Skill 2.2b: Solve systems of linear equations and inequalities using various methods and tools which may include substitution, elimination, matrices, graphing, and graphing calculators.

Item Specifications:

Emphasis:

- The student will solve systems of equations and inequalities.

Stimulus Attributes:

- Test items may include equations and graphs.

Format:

- Identify solutions to systems of equations and inequalities.
- Identify a graph as a solution to a system of equations and/or inequalities.

Content Limits:

- Limit to no more than a 3 x 3 system of equations or inequalities.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Incorrect solutions to systems of equations
- Incorrect graph as solution to system of equations

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Sample Test Items for Skill 2.2b

Depth-of-Knowledge: 2

$$\begin{cases} y - 2x \le -3 \\ 3y + x \ge -4 \end{cases}$$

Which quadrants contain the solutions to this system of inequalities?

A quadrants I and IV

B quadrants II and III

C quadrants III and IV

D quadrants II, III, and IV

Correct Response: **A**

Depth-of-Knowledge: 2

$$\begin{cases} 3x - y + 5 = 0 \\ 2x + 3y - 4 = 0 \end{cases}$$

What is the solution to this system of equations?

A $x = -1,\ y = -2$

B $x = -1,\ y = 2$

C $x = 2,\ y = -1$

D $x = 2,\ y = 1$

Correct Response: **B**

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Depth-of-Knowledge: 3

$$\begin{cases} x + y = 5 \\ x + z = 7 \\ y + z = 16 \end{cases}$$

What is the solution to this system of equations?

A {(2, 3, 9)}

B {(2, 7, 5)}

C {(–2, 8, 8)}

D {(–2, 7, 9)}

Correct Response: **D**

Depth-of-Knowledge: 3

Amy ordered *k* ketchup packets, *m* mustard packets, and *r* relish packets for the concession stand at school. She ordered twice as many mustard packets as relish packets and 100 more ketchup packets than mustard packets. She ordered a total of 1,000 packets. The situation can be modeled by this system of equations.

$$\begin{cases} m = 2r \\ k = 100 + m \\ k + m + r = 1{,}000 \end{cases}$$

How many relish packets did Amy order?

A 180

B 300

C 360

D 460

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.2: Systems of Equations

Oklahoma Academic Skill:

*Skill 2.2c: Use either one quadratic equation and one linear equation or two quadratic equations to solve problems.

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Note: Asterisks (*) have been used to identify standards and objectives that must be assessed by the local school district. All other skills may be assessed by the Oklahoma School Testing Program (OSTP).

OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.3: Quadratic Equations and Functions

Oklahoma Academic Skill:

Skill 2.3a: Solve quadratic equations by graphing, factoring, completing the square, and quadratic formula.

Item Specifications:

Emphasis:

- The student will solve quadratic equations.

Stimulus Attributes:

- Test items may include quadratic equations and steps required for completing the square.

Format:

- Identify solutions to quadratic equations.

Content Limits:

- Limit to equations without the term xy.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Incorrect solutions to systems of equations
- Incorrect graph as solution to system of equations

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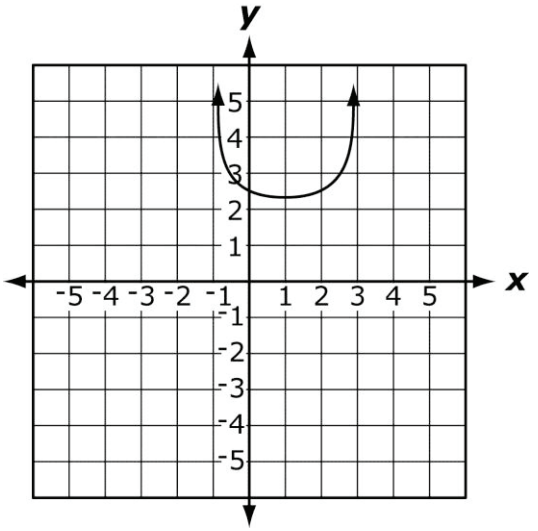
Sample Test Items for Skill 2.3a

Depth-of-Knowledge: 1



How many real roots does the function given by this graph have?

A 0 real roots

B 1 real root

C 2 real roots

D 4 real roots

Correct Response: **A**

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Depth-of-Knowledge: 1

Which equation has –1 and 3 as solutions?

A $x^2 - 2x - 3 = 0$

B $x^2 - 2x + 3 = 0$

C $x^2 + 2x - 3 = 0$

D $x^2 + 2x + 3 = 0$

Correct Response: **A**

Depth-of-Knowledge: 2

What number is added to both sides of the equation $x^2 - 8x +$ ____ $= -3 +$ _____ to solve it by completing the square?

A –16

B 16

C –64

D 64

Correct Response: **B**

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Depth-of-Knowledge: 2

$$10x^2 - x - 3 = 0$$

What is the solution set of this equation?

A $\left\{\frac{-1}{2}, \frac{3}{5}\right\}$

B $\left\{\frac{-3}{5}, \frac{1}{2}\right\}$

C $\left\{\frac{-3}{2}, \frac{1}{5}\right\}$

D $\left\{\frac{-1}{5}, \frac{3}{2}\right\}$

Correct Response: **A**

Depth-of-Knowledge: 2

What are the solutions to $x^2 + 5x - 3 = 0$?

If $ax^2 + bx + c = 0$ and $a \neq 0$, then

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

A $\frac{-5+\sqrt{13}}{2}$ or $\frac{-5-\sqrt{13}}{2}$

B $\frac{-5+\sqrt{37}}{2}$ or $\frac{-5-\sqrt{37}}{2}$

C $\frac{5+\sqrt{13}}{2}$ or $\frac{5-\sqrt{13}}{2}$

D $\frac{5+\sqrt{37}}{2}$ or $\frac{5-\sqrt{37}}{2}$

Correct Response: **B**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.3: Quadratic Equations and Functions

Oklahoma Academic Skill:

Skill 2.3b: Graph a quadratic function and identify the *x*- and *y*-intercepts and maximum or minimum value, using various methods and tools which may include a graphing calculator.

Item Specifications:

Emphasis:

- The student will graph a quadratic function and identify characteristics of that graph.

Stimulus Attributes:

- Test items may include quadratic functions, intercepts, maximum and minimum values, or axes of symmetry.

Format:

- Graph a quadratic function.
- Identify the *x*- and *y*-intercepts and maximum or minimum value on a graph for a quadratic function.
- Compare the *x*- and *y*-intercepts and maximum or minimum value of two quadratic equations.

Content Limits:

- Limit to equations without the term xy.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Incorrect *x*- and *y*-intercepts
- Incorrect maximum or minimum values
- Incorrect graph of quadratic function

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Sample Test Items for Skill 2.3b

Depth-of-Knowledge: 1

What is the *y*-intercept of $f(x) = 3x^2 - 2x + 1$?

A (0, –1)

B (0, 1)

C (–1, 0)

D (1, 0)

Correct Response: **B**

Depth-of-Knowledge: 1

$$f(x) = -x^2$$

In which direction does the graph of this parabola open?

A up

B left

C right

D down

Correct Response: **D**

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Depth-of-Knowledge: 1

$$y = -4x^2 + 2x - 3$$

What is the *y*-intercept of the graph of this equation?

A –3

B 3

C –4

D 4

Correct Response: **A**

Depth-of-Knowledge: 2

What are the coordinates at the minimum point of $f(x) = x^2 - 4x + 3$?

A (–1, –2)

B (–1, 2)

C (2, –1)

D (2, 1)

Correct Response: **C**

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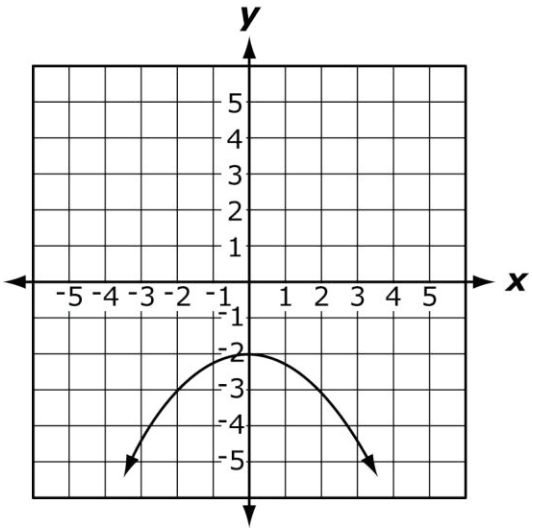
Depth-of-Knowledge: 2



Which function represents this graph?

A $f(x) = \frac{-1}{4}x^2 - 2$

B $f(x) = \frac{1}{4}x^2 - 2$

C $f(x) = -4x^2 - 2$

D $f(x) = 4x^2 - 2$

Correct Response: **A**

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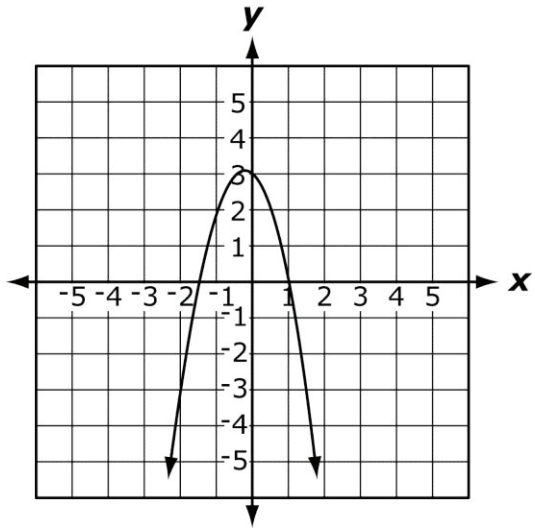
Depth-of-Knowledge: 2



Which function is represented by this graph?

A $f(x) = 2x^2 - x + 3$

B $f(x) = -2x^2 - x + 3$

C $f(x) = 2x^2 - 3x + 1$

D $f(x) = -2x^2 - 3x + 1$

Correct Response: **B**

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Depth-of-Knowledge: 3

$$f(x) = x^2 - x + 6$$
$$g(x) = -3x^2 + 3x + 5$$

Which statement <u>best</u> describes these two functions?

A They have no common points.

B They have the same x-intercepts.

C The maximum of $f(x)$ is the same as the minimum of $g(x)$.

D The maximum of $g(x)$ is the same as the minimum of $f(x)$.

Correct Response: **D**

Depth-of-Knowledge: 3

$$f(x) = x^2 - x + 4$$
$$g(x) = -3x^2 + 3x + 7$$

Which statement <u>best</u> describes these two functions?

A The maximum of $f(x)$ is less than the minimum of $g(x)$.

B The minimum of $f(x)$ is less than the maximum of $g(x)$.

C The maximum of $f(x)$ is greater than the minimum of $g(x)$.

D The minimum of $f(x)$ is greater than the maximum of $g(x)$.

Correct Response: **B**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.3: Quadratic Equations and Functions

Oklahoma Academic Skill:

Skill 2.3c: Model a situation that can be described by a quadratic function and use the model to answer questions about the situation.

Item Specifications:

Emphasis:

- The student will model a situation using a quadratic function.

Stimulus Attributes:

- Test items may include equations, functions, basic geometric formulas, tables, graphs, charts, or diagrams.

Format:

- Identify algebraic expressions and functions that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and equations.
- Formulas for volume and surface area, and the quadratic formula will be provided if appropriate.

Content Limits:

- Do not use exponents greater than 2.
- Do not use functions with the term xy.
- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of formulating functions from context

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Depth-of-Knowledge: 2

The length of a rectangular swimming pool is 20 feet greater than the width. The surface area of the pool is 1,500 square feet. What are the length and width of the pool?

A length = 20 ft, width = 20 ft

B length = 50 ft, width = 30 ft

C length = 60 ft, width = 40 ft

D length = 150 ft, width = 10 ft

Correct Response: **B**

Depth-of-Knowledge: 2

A company is selling an item and determines that the profit from selling the item for a price of *x* dollars is given by the function below.

$$p(x) = -\frac{1}{4}(x-16)^2 + 4$$

Which price will maximize the profit?

A $4

B $12

C $16

D $20

Correct Response: **C**

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Depth-of-Knowledge: 3

The path of a kicked soccer ball can be modeled by the function $f(x) = 26 + 2x - x^2$, where x is the horizontal distance (in meters) and $f(x)$ is the height (in meters). If the height is 2 meters, what is the horizontal distance?

A 4 meters

B 6 meters

C 12 meters

D 24 meters

Correct Response: **B**

Depth-of-Knowledge: 3

A landscape designer has to construct a rectangular flower bed with a perimeter of 100 feet and the maximum possible area. What is the area of the flower bed?

A 25 sq. ft

B 100 sq. ft

C 625 sq. ft

D 2,500 sq. ft

Correct Response: **C**

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Depth-of-Knowledge: 3

The profit, *P*, (in dollars) for Ace Car Rental is given by $P = 100x - 0.1x^2$, where *x* is the number of cars rented. How many cars have to be rented for the company to maximize profits?

A 500 cars

B 1,000 cars

C 12,500 cars

D 25,000 cars

Correct Response: **A**

Depth-of-Knowledge: 3

The revenue, *R*, at a bowling alley is given by the equation $R = -\frac{1}{800}\left(x^2 - 2{,}400x\right)$, where *x* is the number of frames bowled. What is the maximum amount of revenue the bowling alley can generate?

A $800

B $1,200

C $1,800

D $2,400

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.4: Identify, graph, and write the equations of the conic sections (circle, ellipse, parabola, and hyperbola).

Item Specifications:

Emphasis:

- The student will identify, graph, and write the equations and characteristics of conic sections.

Stimulus Attributes:

- Test items may include equations in standard or general form, graphs, and names of conic sections.

Format:

- Identify basic shapes of conics.
- Write an equation of the conics given basic information, including the vertex, radius, center, or major or minor axis.
- Sketch a graph of the conics.

Content Limits:

- Limit to questions without reference to foci or directrix.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Incorrect equations, graphs or names of conics

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Depth-of-Knowledge: 1

Which best describes the graph of $\frac{x^2}{50} + \frac{y^2}{25} = 1$?

A circle

B ellipse

C parabola

D hyperbola

Correct Response: **B**

Depth-of-Knowledge: 2

What is the equation of a circle with center (–4, 2) and diameter 6?

A $(x-4)^2 + (y+2)^2 = 6$

B $(x+4)^2 + (y-2)^2 = 6$

C $(x-4)^2 + (y+2)^2 = 9$

D $(x+4)^2 + (y-2)^2 = 9$

Correct Response: **D**

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Depth-of-Knowledge: 2

Which statement describes the graph of the equation $y = -x^2 + 6x - 8$?

A It is a vertical parabola.

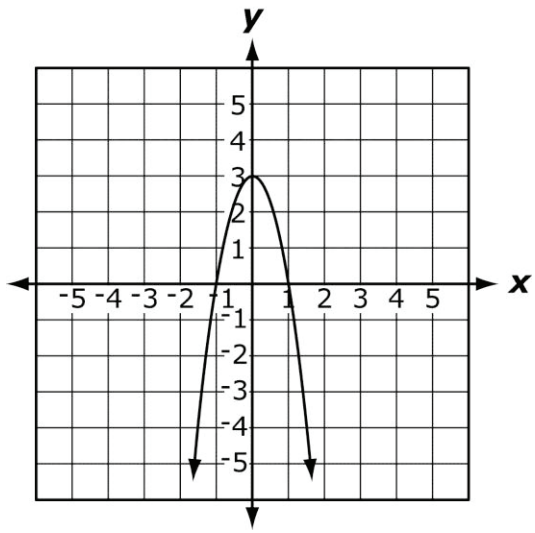
B It is a vertical hyperbola.

C It is a horizontal parabola.

D It is a horizontal hyperbola.

Correct Response: **A**

Depth-of-Knowledge: 2



What is the equation of the given parabola?

A $y = -x^2 + 3$

B $y = -3x^2 + 3$

C $y = -x^2 - 2x + 3$

D $y = 3x^2 - 6x + 3$

Correct Response: **B**

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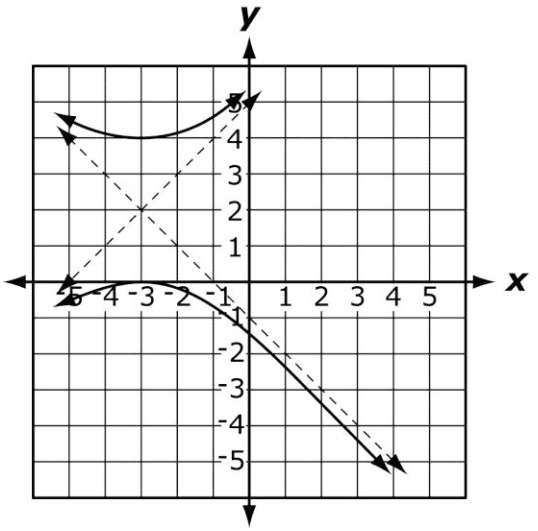
Depth-of-Knowledge: 2



What is the equation of the graphed hyperbola?

A $\frac{(x+3)^2}{4} - \frac{(y-2)^2}{4} = 1$

B $\frac{(y+2)^2}{4} - \frac{(y-3)^2}{4} = 1$

C $\frac{(x-2)^2}{2} - \frac{(x+3)^2}{2} = 1$

D $\frac{(y-2)^2}{4} - \frac{(x+3)^2}{4} = 1$

Correct Response: **D**

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Depth-of-Knowledge: 2

What is the vertex of the parabola $y = (x - 1)^2 - 9$?

A $(-1, -9)$

B $(1, -9)$

C $(-9, -1)$

D $(-9, 1)$

Correct Response: **B**

Depth-of-Knowledge: 3

What is the equation of the ellipse whose center is at the origin, major axis has length of 10 units along the *x*-axis, and minor axis has length of 6 units?

A $\frac{x^2}{25} + \frac{y^2}{9} = 1$

B $\frac{x^2}{9} + \frac{y^2}{25} = 1$

C $\frac{x^2}{20} + \frac{y^2}{12} = 1$

D $\frac{x^2}{100} + \frac{y^2}{36} = 1$

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.5: Exponential and Logarithmic Functions

Oklahoma Academic Skill:

Skill 2.5a: Graph exponential and logarithmic functions.

Item Specifications:

Emphasis:

- The student will graph exponential and logarithmic functions to solve problems.

Stimulus Attributes:

- Test items may include tables, functions, and graphs.
- A logarithm is understood to have base 10 unless otherwise specified.
- Items may include natural logarithms.

Format:

- Identify algebraic expressions and functions that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and equations.
- Graph exponential and logarithmic functions.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Interchange of exponential and logarithmic functions

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Depth-of-Knowledge: 1

x	0	1	2	3	4
y	1	3	9	27	81

Which function is best represented by the data in this table?

A $f(x) = x^3$

B $f(x) = 3^x$

C $f(x) = 3x$

D $f(x) = 3x^2$

Correct Response: **B**

Depth-of-Knowledge: 2

$$f(x) = 2^{-x} + 7$$

What are the horizontal asymptote and *y*-intercept for the graph of this function?

A Asymptote: $y = 7$, Intercept: (0, 7)

B Asymptote: $y = -7$, Intercept: (0, 7)

C Asymptote: $y = 7$, Intercept: (0, 8)

D Asymptote: $y = -7$, Intercept: (0, 8)

Correct Response: **C**

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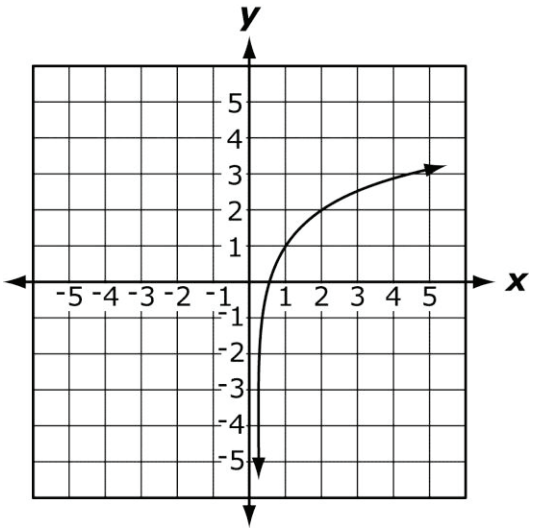
Depth-of-Knowledge: 3



Which function is <u>best</u> represented by this graph?

A $f(x) = \log_2 x + 1$

B $f(x) = \log_2 x - 1$

C $f(x) = \log_2(x + 1)$

D $f(x) = \log_2(x - 1)$

Correct Response: **A**

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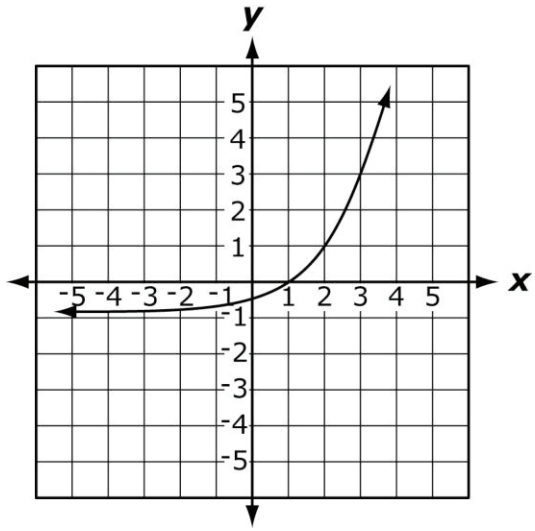
Depth-of-Knowledge: 3



Which function is <u>best</u> represented by this graph?

A $f(x) = 2^{x-1} - 1$

B $f(x) = 2^{x+1} - 1$

C $f(x) = 2^{x} - \frac{1}{2}$

D $f(x) = 2^{x-1}$

Correct Response: **A**

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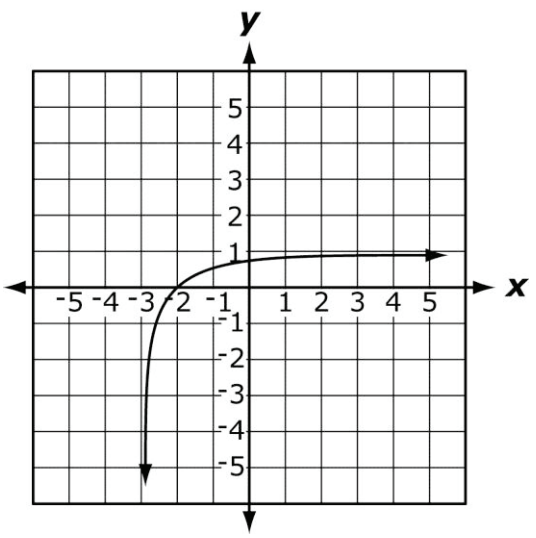
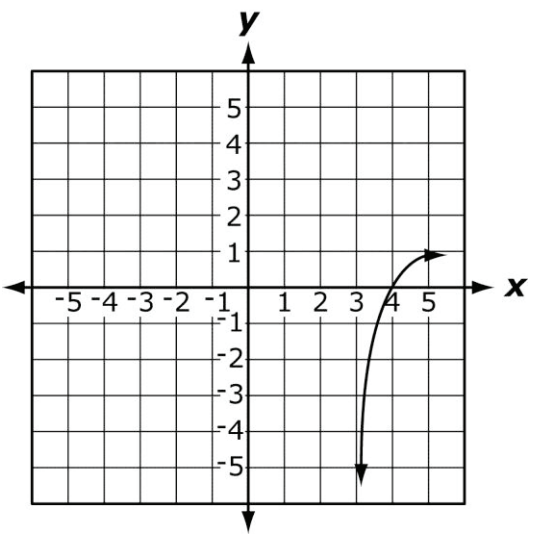
Depth-of-Knowledge: 3

Which graph represents the function $f(x) = \log(x + 3)$?

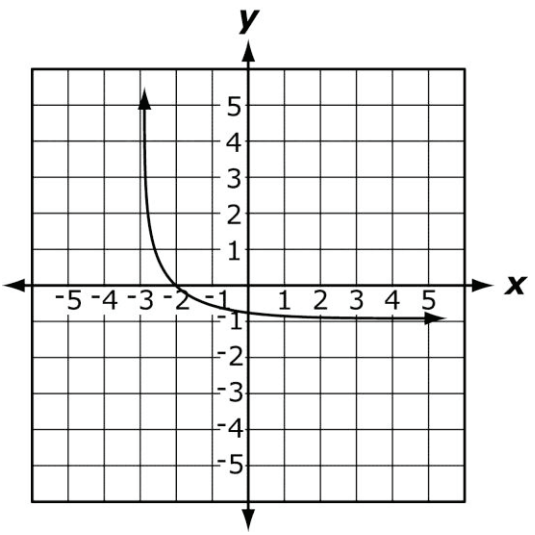
A



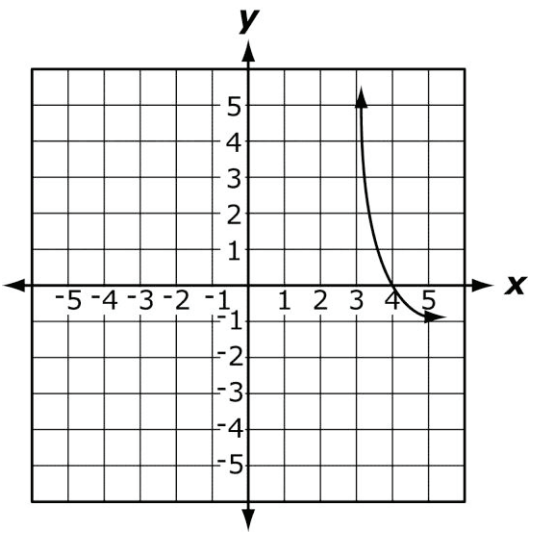
B



C



D



Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.5: Exponential and Logarithmic Functions

Oklahoma Academic Skill:

Skill 2.5b: Apply the inverse relationship between exponential and logarithmic functions to convert from one form to another.

Item Specifications:

Emphasis:

- The student will use the inverse relationship between exponential and logarithmic functions to solve problems.

Stimulus Attributes:

- Test items may include exponential and logarithmic functions.
- Items may include natural logarithms.

Format:

- Identify algebraic expressions that represent mathematical exponential and logarithmic functions.
- Convert from one form to another.

Content Limits:

- Limit to no more than three distinct operations.

Primary Process Standards:

- Problem Solving

Distractor Domain:

- Common algebraic misconceptions
- Interchange of exponential and logarithmic functions
- Reciprocals

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Sample Test Items for Skill 2.5b

Depth-of-Knowledge: 1

Which function is the inverse of $f(x) = \log x$?

A $f^{-1}(x) = e^x$

B $f^{-1}(x) = 2^x$

C $f^{-1}(x) = 10^x$

D $f^{-1}(x) = \dfrac{1}{\log x}$

Correct Response: **C**

Depth-of-Knowledge: 2

If $3^{\log_3 7} = x$, what is the value of x?

A 7

B 3^7

C $\sqrt[3]{7}$

D $\sqrt[7]{3}$

Correct Response: **A**

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Depth-of-Knowledge: 2

Which of these represents the solution for x in $6^x = 21$?

A $x = \frac{\log 6}{\log 21}$

B $x = \frac{\log 21}{\log 6}$

C $x = \log 21 - \log 6$

D $x = \log 21 + \log 6$

Correct Response: **B**

Depth-of-Knowledge: 2

What is the value of $\log \sqrt{10}$?

A 0

B $\frac{1}{2}$

C 1

D 10

Correct Response: **B**

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Depth-of-Knowledge: 2

If $4\left(\log_3 \frac{1}{27}\right) = 27$ what is the value of *x*?

A $\frac{4}{3}$

B $\frac{-4}{3}$

C 12

D −12

Correct Response: **D**

Depth-of-Knowledge: 3

If $\log_{2x} 80 = 2$, what is the value of *x*?

A 20

B $2\sqrt{5}$

C $5\sqrt{2}$

D $2\sqrt{10}$

Correct Response: **B**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.5: Exponential and Logarithmic Functions

Oklahoma Academic Skill:

Skill 2.5c: Model a situation that can be described by an exponential or logarithmic function, and use the model to answer questions about the situation.

Item Specifications:

Emphasis:

- The student will model a situation that can be described by an exponential or logarithmic function to solve problems.

Stimulus Attributes:

- Test items may include context, functions, formulas, tables, graphs, charts, or diagrams.
- Items may include natural logarithms.

Format:

- Identify algebraic expressions and functions that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and functions to include decay, growth, and interest compounded continuously.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Interchange of exponential and logarithmic functions
- Reciprocals
- Misconceptions of modeling from context

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Depth-of-Knowledge: 2

Loudness of fizz in a can of soda pop is represented by $F = 4\log\left(\frac{x}{10^{-5}}\right)$, where x is represented by the intensity of sound. How loud is the fizz, if $x = 10^{-3}$?

A 4 decibels

B 8 decibels

C 16 decibels

D 32 decibels

Correct Response: **B**

Depth-of-Knowledge: 2

$$r = 2^{\left(\frac{1}{x}\right)} - 1$$

This formula gives the annual interest rate, r, required for your money to double in x years. If it takes 18 years for your money to double, what was the approximate annual interest rate?

A 2%

B 4%

C 8%

D 18%

Correct Response: **B**

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Depth-of-Knowledge: 3

The mass of a radioactive sample is given by $M(t) = M_0 10^{-kt}$, where t is the time in years, M_0 is the initial mass, and k is a constant. If 400 grams of this material decays to 40 grams in 10 years, what is the value of k?

A 1

B –1

C 0.1

D –0.1

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.6: Polynomial Equations and Functions

Oklahoma Academic Skill:

Skill 2.6a: Solve polynomial equations using various methods and tools which may include factoring and synthetic division.

Item Specifications:

Emphasis:

- The student will use the relationships among the solution of an equation and factors of a polynomial expression to solve problems.

Stimulus Attributes:

- Test items may include context and polynomial equations.

Format:

- Identify solutions to higher-degree polynomial equations.
- Identify algebraic expressions and equations that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and equations.

Content Limits:

- Limit to three factors for a polynomial equation.
- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of solving polynomial equations

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Depth-of-Knowledge: 2

$$f(x) = x^3 - 3x^2 - 4x + 12$$

Which of these is a root of $f(x)$?

A -3

B 3

C 4

D 12

Correct Response: **B**

Depth-of-Knowledge: 2

$$2x^3 + 13x^2 + 17x - 12$$

Given that $(2x - 1)$ and $(x + 3)$ are factors of this polynomial, what is the third factor?

A $x - 4$

B $x + 4$

C $x - 6$

D $x + 6$

Correct Response: **B**

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Depth-of-Knowledge: 3

A rectangular prism has a volume of 120 cubic inches. The length of the prism is 5 inches, the width is $(x - 2)$ inches, and the height is $(x + 3)$ inches. What are the width and height of the prism?

$$V = Bh$$

A width: 3 in., height: 8 in.

B width: 4 in., height: 6 in.

C width: 6 in., height: 4 in.

D width: 8 in., height: 3 in.

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.6: Polynomial Equations and Functions

Oklahoma Academic Skill:

Skill 2.6b: Sketch the graph of a polynomial function.

Emphasis:

- The student will sketch the graph of a polynomial function to solve problems.

Stimulus Attributes:

- Test items may include polynomial functions and graphs.

Format:

- Identify the graph for a polynomial function.

Content Limits:

- Limit equations to fourth degree polynomials.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of graphs for polynomial functions

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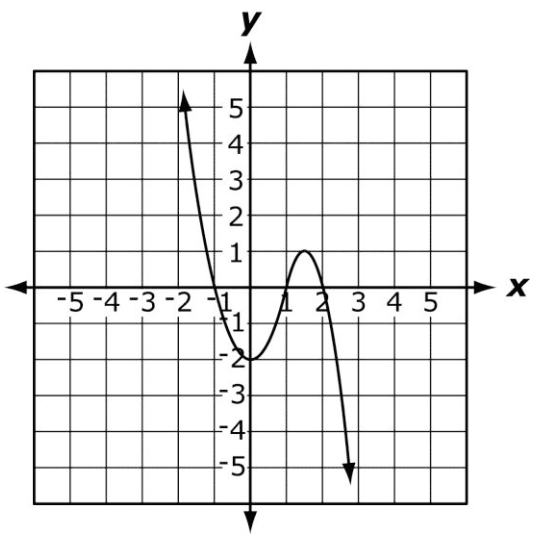
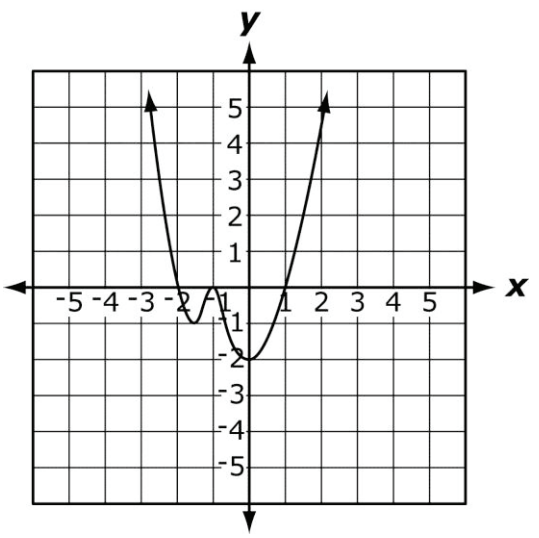
Depth-of-Knowledge: 2

What is the graph of the polynomial $y = x^3 + 2x^2 - x - 2$?

A



B



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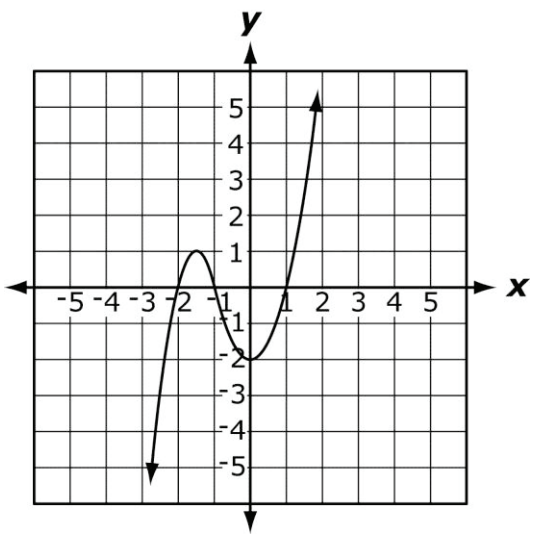

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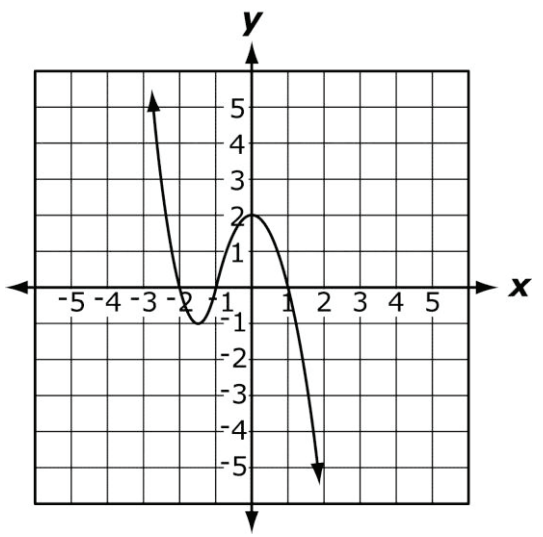

Correct Response: **C**

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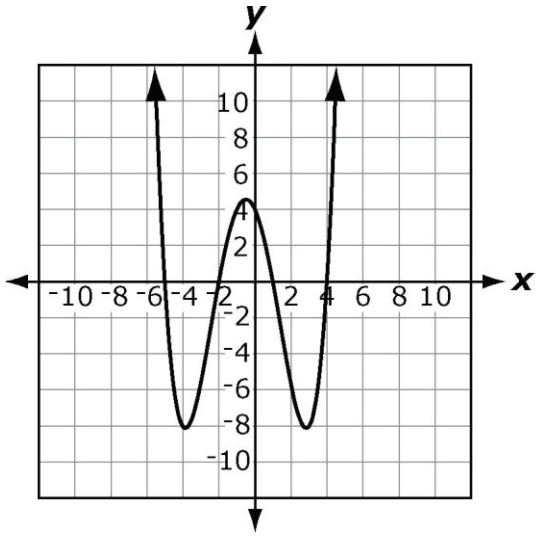
Depth-of-Knowledge: 3



Which equation is represented by this graph?

A $y = 0.1(x+5)(x-4)(x-1)(x+2)$

B $y = 0.1(x-5)(x+4)(x+1)(x-2)$

C $y = -0.1(x+5)(x-4)(x-1)(x+2)$

D $y = -0.1(x-5)(x+4)(x+1)(x-2)$

Correct Response: **A**

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Depth-of-Knowledge: 3

Which statement describes the characteristics of the graph of $f(x) = -5x^4 + 3x^2 + x - 2$?

A The graph primarily increases in the third quadrant and increases in the first quadrant.

B The graph primarily decreases in the second quadrant and increases in the first quadrant.

C The graph primarily increases in the third quadrant and decreases in the fourth quadrant.

D The graph primarily decreases in the second quadrant and decreases in the fourth quadrant.

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.6: Polynomial Equations and Functions

Oklahoma Academic Skill:

Skill 2.6c: Given the graph of a polynomial function, identify the x-and y-intercepts, relative maximums and relative minimums, using various methods and tools which may include a graphing calculator.

Item Specifications:

Emphasis:

- The student will identify the x- and y-intercepts, relative maximums and relative minimums of a polynomial function to solve problems.

Stimulus Attributes:

- Test items may include polynomial functions, graphs, or specific coordinates of graph characteristics.

Format:

- Identify the characteristics of a graph for a polynomial function.

Content Limits:

- Limit to identification of no more than 3 characteristics.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of graphs for polynomial functions
- Interchange of x and y
- Interchange of maximum and minimum

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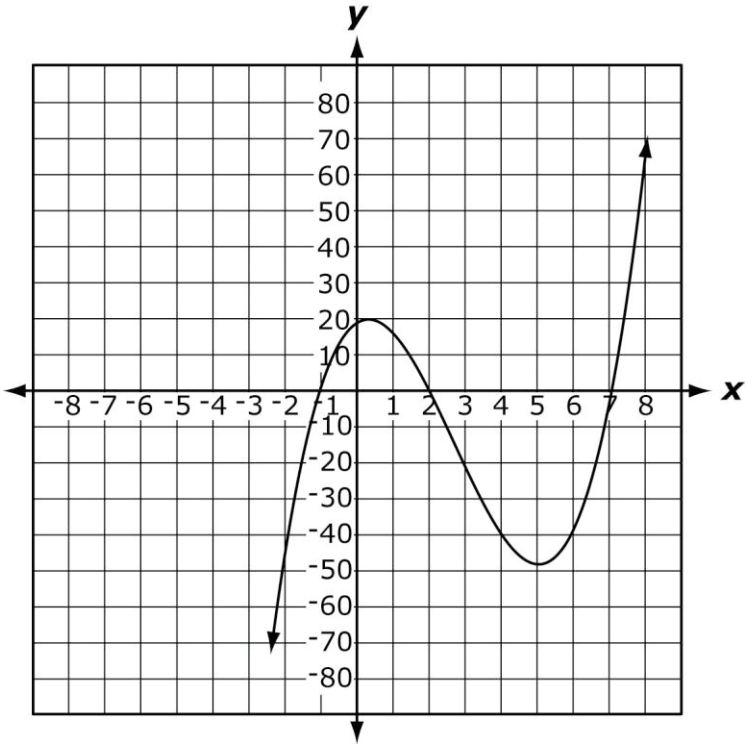
Depth-of-Knowledge: 1



What are the *x*- and *y*-intercepts of this graphed function?

A *x*-intercepts: (–1, 0), (2, 0), (7, 0); *y*-intercept: (0, 28)

B *x*-intercept: (0, 28) ; *y*-intercepts: (–1, 0), (2, 0), (7, 0)

C *x*-intercepts: (1, 0), (–2, 0), (–7, 0); *y*-intercept: (0, 28)

D *x*-intercept: (0, 28) ; *y*-intercepts: (1, 0), (–2, 0), (–7, 0)

Correct Response: **A**

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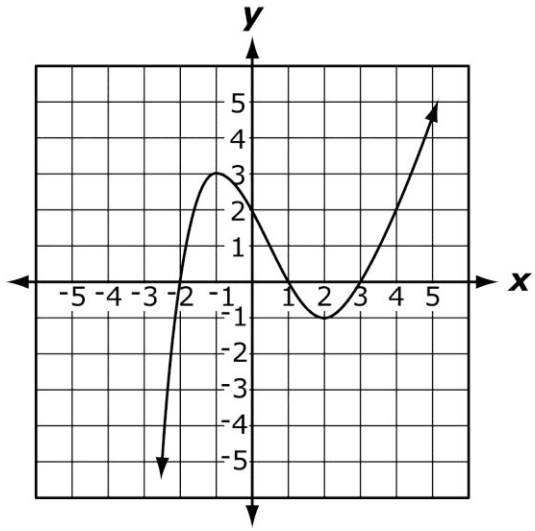
Depth-of-Knowledge: 1



What is the set of *x*-intercepts of this graphed function?

A {2}

B {⁻1, 2}

C {⁻1, 3}

D {⁻2, 1, 3}

Correct Response: **D**

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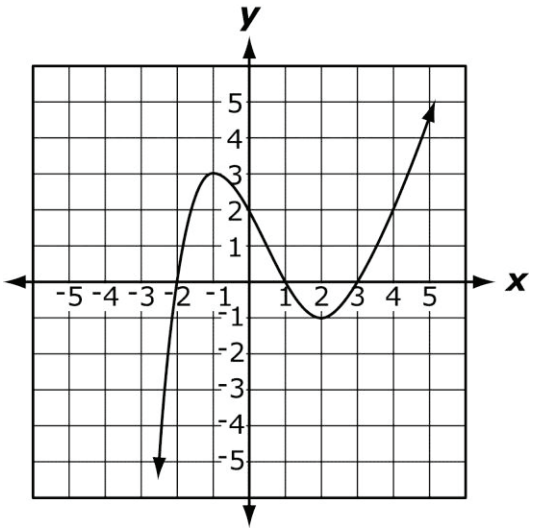
Depth-of-Knowledge: 2



What is the set of approximate *y*-values of the relative minimum and maximum of this graphed function?

A $\{2\}$

B $\{^{-}1, 2\}$

C $\{^{-}1, 3\}$

D $\{^{-}2, 1, 3\}$

Correct Response: **C**

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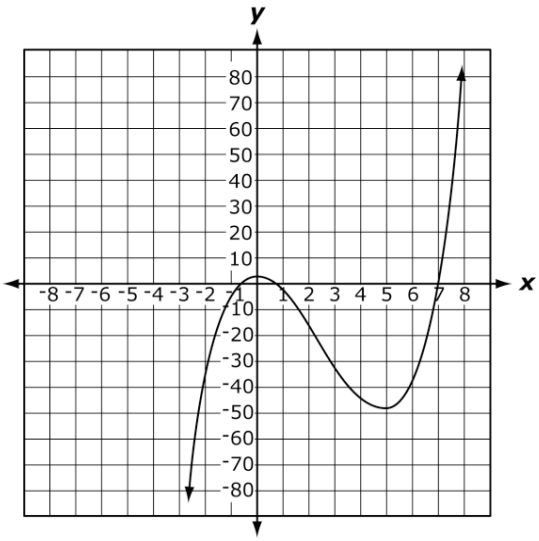
Depth-of-Knowledge: 2



What are the properties of the point (0, 3) in this graphed function?

A It is a relative minimum and an *x*-intercept.

B It is a relative maximum and an *x*-intercept.

C It is a relative minimum and a *y*-intercept.

D It is a relative maximum and a *y*-intercept.

Correct Response: **D**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.6: Polynomial Equations and Functions

Oklahoma Academic Skill:

Skill 2.6d: Model a situation that can be described by a polynomial function and use the model to answer questions about the situation.

Item Specifications:

Emphasis:

- The student will model a situation that can be described by a polynomial function to solve problems.

Stimulus Attributes:

- Test items may include context, functions, tables, graphs, charts, or diagrams.
- Test items may include direct or inverse variation.

Format:

- Identify algebraic expressions and functions that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and functions.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of polynomial functions
- Misconceptions of modeling from context

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Depth-of-Knowledge: 2

In a science fiction novel, a scientist proposes an equation that relates the distance (d) in meters between an object in space and a black hole and the time (t) in seconds the object will take to be pulled into the black hole.

$$d = 32t^4 + 16t^3 + 8t^2 + 4t$$

How far is the object from the black hole if the object will be pulled into the black hole in 10 seconds?

A 22,000 meters

B 336,840 meters

C 2,095,000 meters

D 2,431,800 meters

Correct Response: **B**

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Depth-of-Knowledge: 2

Two silos are each in the shape of a cylinder with a height of 60 feet and a radius *r*, and both are capped with a semispherical roof. The volume, *V*, in cubic feet of each silo is given by $V = \frac{2}{3}\pi r^3 + 60\pi r^2$. What is the difference between the volumes of a silo with a radius of 10 feet and a silo with a radius of 15 feet? (Use 3.14 for π.)

A 4,971.7 cubic feet

B 20,933.3 cubic feet

C 28,521.7 cubic feet

D 49,455.0 cubic feet

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.7: Rational Equations and Functions

Oklahoma Academic Skill:

Skill 2.7a: Solve rational equations.

Item Specifications:

Emphasis:

- The student will use the relationships among the solution of an equation and factors of a rational expression to solve problems.

Stimulus Attributes:

- Test items may include context and rational equations.

Format:

- Identify solutions to rational equations.
- Identify algebraic expressions and rational equations that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and rational equations.

Content Limits:

- Limit the equation to include no more than three unlike denominators.
- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of solving rational equations

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Sample Test Items for Skill 2.7a

Depth-of-Knowledge: 1

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

What is the value of *x* in this rational equation?

A 2

B 3

C 4

D 5

Correct Response: **D**

Depth-of-Knowledge: 2

$$2x = \frac{4x+5}{3}$$

What is the value of *x* in this rational equation?

A –4

B –1

C $\frac{1}{2}$

D $\frac{5}{2}$

Correct Response: **D**

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Depth-of-Knowledge: 3

$$\frac{5}{2x-2} - \frac{9}{2x} = \frac{-1}{4}$$

What is the solution set of this rational equation?

A {6}

B {–3}

C {3, 6}

D {–3, –6}

Correct Response: **C**

Depth-of-Knowledge: 3

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

What is the solution set of this rational equation?

A {–3, –2}

B {–3, 2}

C {–2, 3}

D {2, 3}

Correct Response: **C**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.7: Rational Equations and Functions

Oklahoma Academic Skill:

Skill 2.7b: Sketch the graph of a rational function.

Item Specifications:

Emphasis:

- The student will sketch the graph of a rational function to solve problems.

Stimulus Attributes:

- Test items may include rational functions and graphs.
- Test items may include identification of asymptotes.

Format:

- Identify the graph for a rational function.
- Identify the set of ordered pairs that satisfy a rational function.

Content Limits:

- Limit to rational functions.
- Limit to items that do not require the use of slant asymptotes.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of graphs for rational functions

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Sample Test Items for Skill 2.7b

Depth-of-Knowledge: 1

$$f(x) = \frac{1}{x+4}$$

What is the vertical asymptote of the graph of $f(x)$?

A $x = -4$

B $x = -1$

C $x = 1$

D $x = 4$

Correct Response: **A**

Depth-of-Knowledge: 1

$$f(x) = \frac{4 - x^2}{x}$$

What is the vertical asymptote of the graph of $f(x)$?

A $x = 4$

B $x = 2$

C $x = 0$

D $x = -2$

Correct Response: **C**

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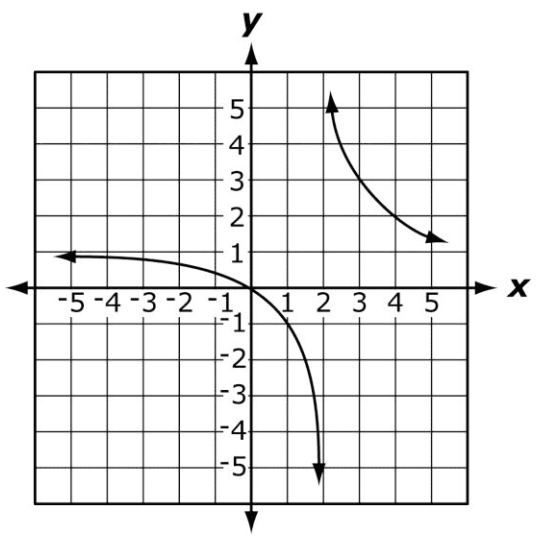
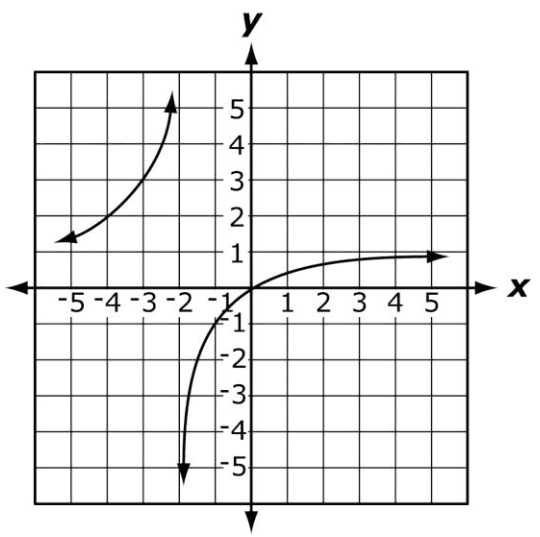
Depth-of-Knowledge: 2

What is the graph of the function $f(x) = \dfrac{x}{x-2}$?

A



B



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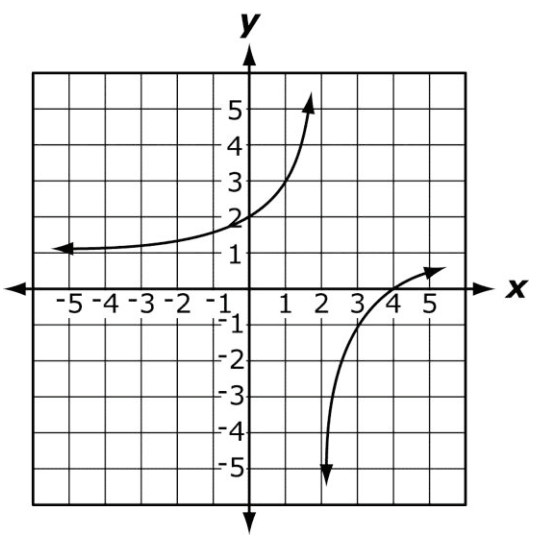
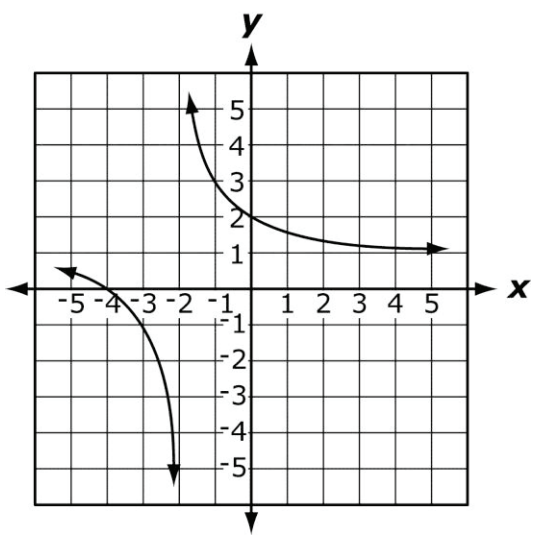


D



Correct Response: **A**

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Depth-of-Knowledge: 2

$$y = \frac{x - 2}{x^2 + 4}$$

How many vertical asymptotes does the graph of this equation have?

A 0 vertical asymptotes

B 1 vertical asymptote

C 2 vertical asymptotes

D 4 vertical asymptotes

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.7: Rational Equations and Functions

Oklahoma Academic Skill:

Skill 2.7c: Given the graph of a rational function, identify the x-and y-intercepts, and vertical asymptotes, using various methods and tools which may include a graphing calculator.

Item Specifications:

Emphasis:

- The student will identify the x- and y-intercepts and vertical asymptotes of a rational function.

Stimulus Attributes:

- Test items may include rational functions and graphs.
- Test items may include vertical asymptotes.

Format:

- Identify the characteristics of a graph for a rational function.

Content Limits:

- Limit to identification of no more than 3 characteristics.
- Limit to items that do not require the use of slant asymptotes.

Primary Process Standards:

- Problem Solving
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of graphs for rational functions
- Interchange of x and y
- Interchange of maximum and minimum

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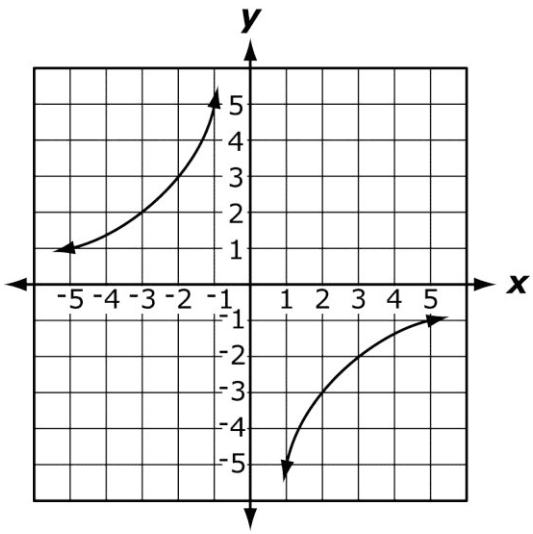
Depth-of-Knowledge: 1



What is the vertical asymptote of this graph?

A $x = 0$

B $y = 0$

C $x = 2.5$

D $y = 2.5$

Correct Response: **A**

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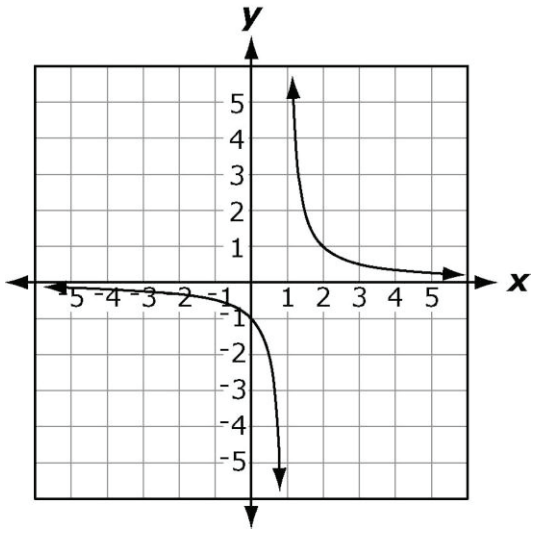
Depth-of-Knowledge: 2



How many *x*-intercepts does the graph of this equation have?

A 0

B 1

C 2

D 4

Correct Response: **A**

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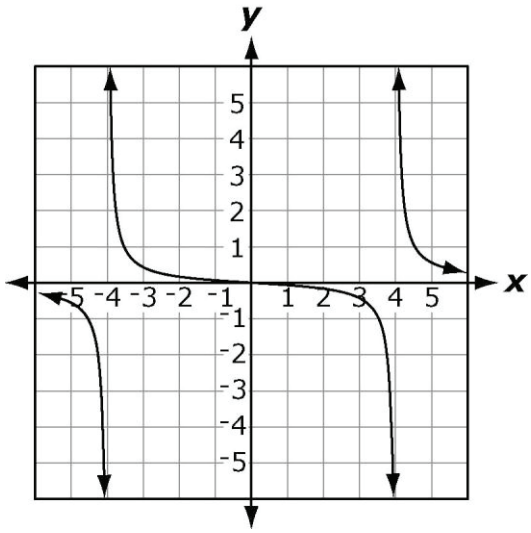
Depth-of-Knowledge: 2



What are the vertical asymptote(s) of this function?

A $x = \pm 4$

B $y = \pm 4$

C $x = 0$

D $y = 0$

Correct Response: **A**

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OAS:

Standard 2: Relations and Functions

Oklahoma Academic Objective:

Objective 2.7: Rational Equations and Functions

Oklahoma Academic Skill:

Skill 2.7d: Model a situation that can be described by a rational function, and use the model to answer questions about the situation.

Item Specifications:

Emphasis:

- The student will model a situation that can be described by a rational function to solve problems.

Stimulus Attributes:

- Test items may include context, functions, tables, graphs, charts, or diagrams.

Format:

- Identify algebraic expressions and rational functions that represent mathematical and real-world situations.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and rational functions.
- Use formulas for surface area and volume of geometric solids.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of rational functions
- Misconceptions of modeling from context

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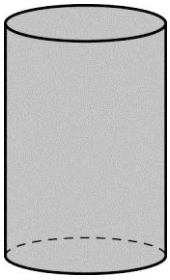
Depth-of-Knowledge: 1



If the surface area of the closed cylinder is 25 square inches, which equation represents the height of the cylinder in terms of *r*?

$$SA = 2\pi rh + 2\pi r^2$$

A $h = \dfrac{25 + 2\pi r^2}{2\pi r}$

B $h = \dfrac{25 - 2\pi r^2}{2\pi r}$

C $h = 25 + r$

D $h = 25 - r$

Correct Response: **B**

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Depth-of-Knowledge: 2

$$F = \frac{19(3+2t)}{1+0.05t}$$

A homeowner stocked his pond with fish. The number of fish, *F*, increases according to the above equation, where *t* is the time in years. What is the approximate number of fish after 10 years?

A 49 fish

B 69 fish

C 138 fish

D 291 fish

Correct Response: **D**

Depth-of-Knowledge: 2

The intensity, *L*, of light varies inversely with the square of the distance, *r*, from the source of the light. Given that *k* is the constant of proportionality, which equation describes this relationship?

A $L = 2kr$

B $L = \frac{k}{r^2}$

C $L = k\sqrt{r}$

D $L = k\,r^2$

Correct Response: **B**

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Depth-of-Knowledge: 2

The cost, *C*, in dollars, to remove *x* percent of the trash left after a parade is modeled by the equation $C = \frac{450x}{225 - x}$. Approximately what percent of trash will be removed if $100 is spent?

A 41%

B 50%

C 59%

D 64%

Correct Response: **A**

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OAS:

Standard 3: Data Analysis and Statistics

Oklahoma Academic Objective:

Objective 3.1: Analysis of Collected Data Involving Two Variables

Oklahoma Academic Skill:

Skill 3.1a: Interpret data on a scatter plot using a linear, exponential, or quadratic model/equation.

Item Specifications:

Emphasis:

- The student will interpret results using a linear, exponential, or quadratic model/equation.

Stimulus Attributes:

- Test items may include tables, scatter plots, charts, or diagrams.
- Test items may include increasing or decreasing functions.
- Test items may include positive, negative, or no correlation.

Format:

- Identify scatter plots that represent mathematical and real-world situations.
- Identify correct conclusions from data on a scatter plot.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Communication
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of scatter plots
- Interchange of x- and y-axes
- Misconceptions of a linear, exponential, or quadratic model

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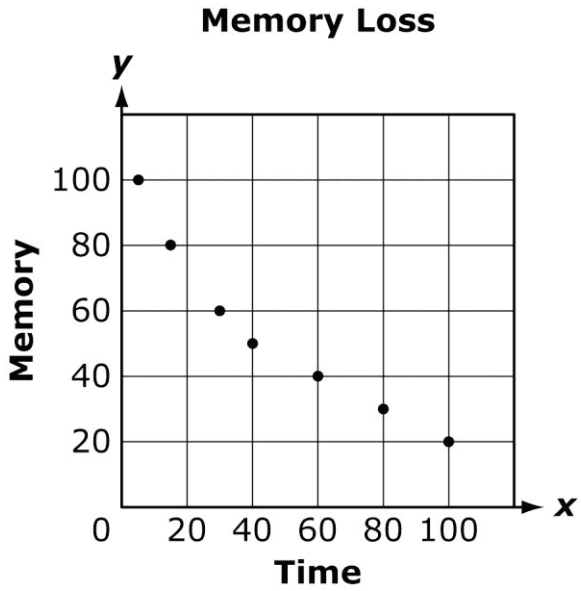
Depth-of-Knowledge: 1



Which set of data <u>best</u> represents the data on the scatter plot?

A

Time	10	30	60	80	100
Memory	95	60	40	30	20

B

Time	10	30	60	80	100
Memory	20	30	40	60	95

C

Time	10	30	60	80	100
Memory	100	80	60	40	20

D

Time	10	30	60	80	100
Memory	85	60	50	40	20

Correct Response: **A**

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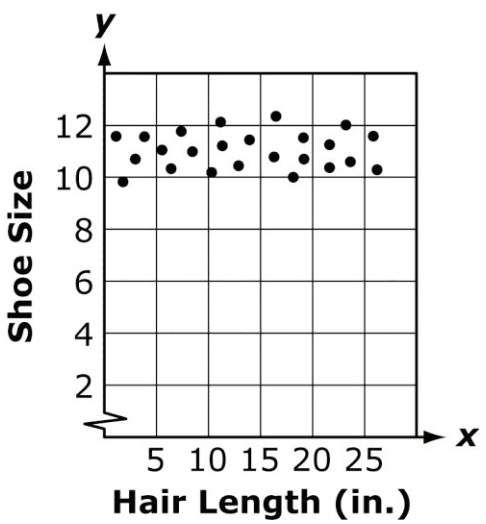
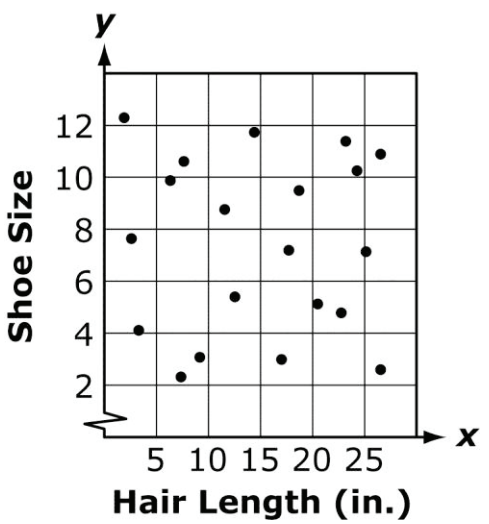
Depth-of-Knowledge: 2

There is no correlation between a person's hair length and shoe size. Which scatter plot <u>best</u> represents this situation?

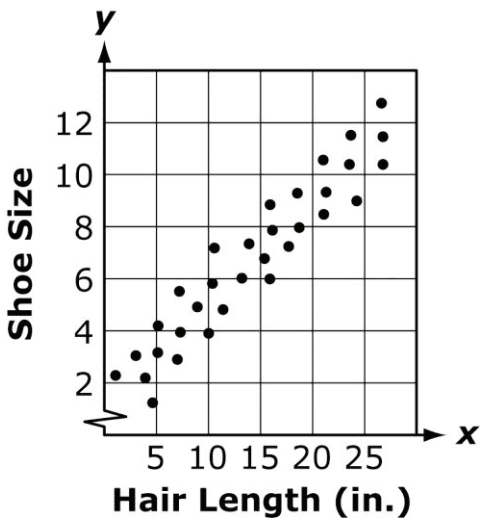
A



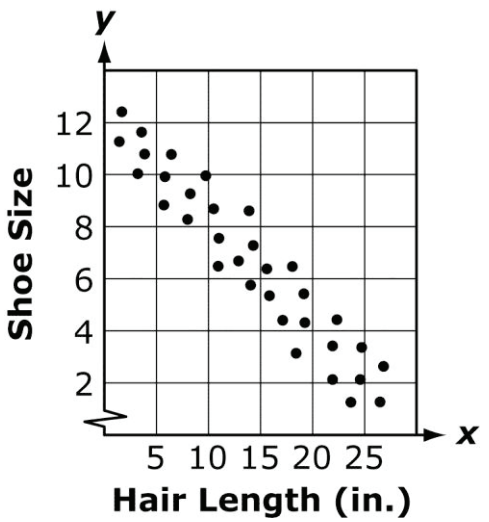
B



C



D



Correct Response: **B**

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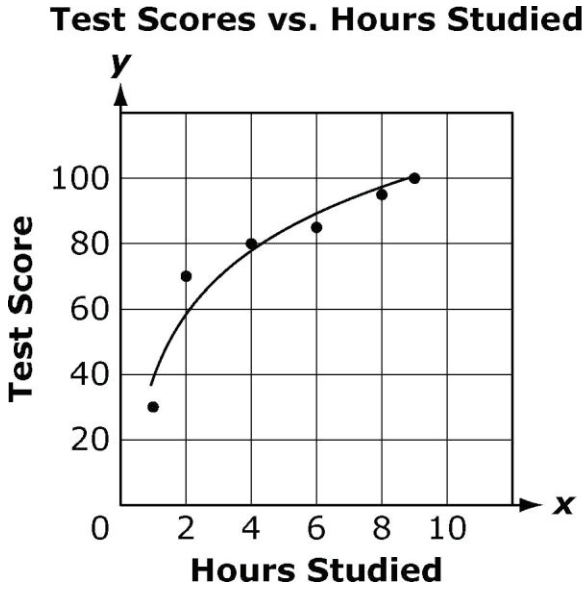
Depth-of-Knowledge: 2

The test scores and hours studied of 6 students were put into a scatter plot.



If another student studies 2 hours, what is the <u>most likely</u> test score based on the curve of best fit?

A 20

B 60

C 70

D 80

Correct Response: **B**

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OAS:

Standard 3: Data Analysis and Statistics

Oklahoma Academic Objective:

Objective 3.1: Analysis of Collected Data Involving Two Variables

Oklahoma Academic Skill:

Skill 3.1b: Identify whether the model/equation is a curve of best fit for the data, using various methods and tools which may include a graphing calculator.

Item Specifications:

Emphasis:

- The student will identify whether the model/equation is a curve of best fit for the data, using various methods and tools.

Stimulus Attributes:

- Test items may include tables, scatter plots, charts, or diagrams.

Format:

- Identify a best fit for a model that represents mathematical and real-world situations.
- Identify a best-fit equation or function from data on a scatter plot.

Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Communication
- Connections
- Representation

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of scatter plots
- Interchange of x- and y-axes
- Misconceptions of a linear, exponential, or quadratic model

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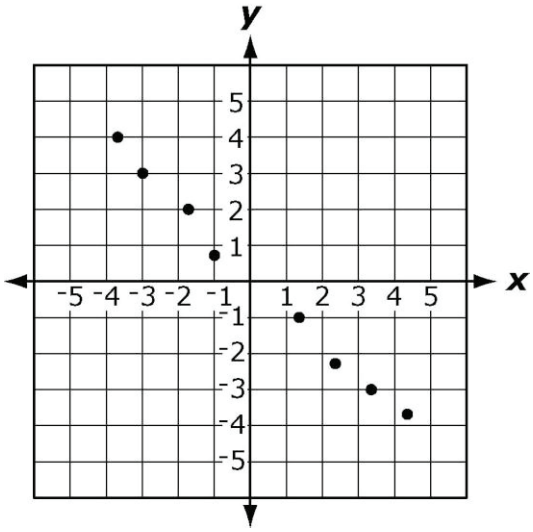
Depth-of-Knowledge: 1



Which equation <u>most</u> closely models the data in the scatter plot?

A $y = x$

B $y = -x$

C $y = 2x$

D $y = -2x$

Correct Response: **B**

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Depth-of-Knowledge: 1

Growth vs. Time

Time	Growth
2	1
4	2
5	3.5
6	6
6.5	8.5

Which type of function <u>best</u> models the data in this scatter plot?

A exponential

B logarithmic

C quadratic

D linear

Correct Response: **A**

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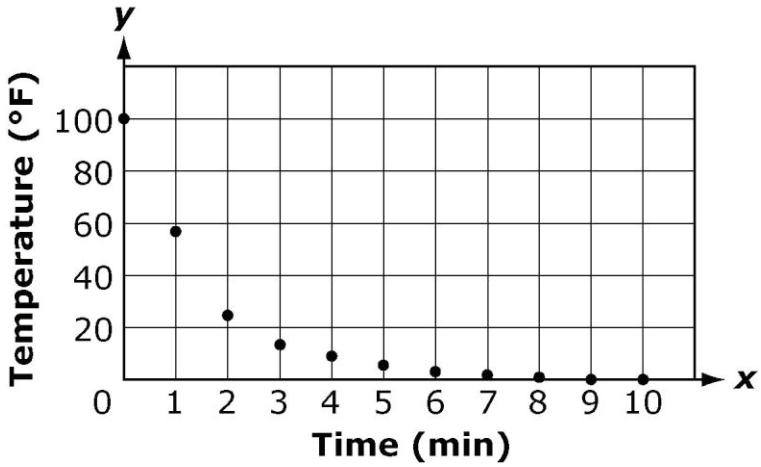
Depth-of-Knowledge: 1

Students in a science classroom perform an experiment to find the rate at which a hot liquid cools in a freezer. They plot the temperature over time and obtain the following graph.



Which type of function <u>best</u> models the data in this scatter plot?

A exponential

B logarithmic

C quadratic

D linear

Correct Response: **A**

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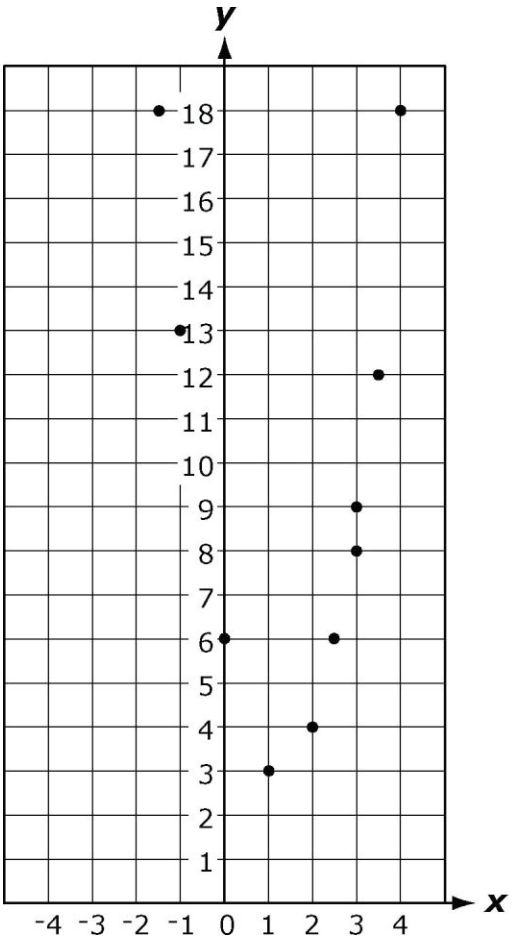
Depth-of-Knowledge: 2



Which equation <u>most</u> closely models the data in the scatter plot?

A $y = x^2 - 4x + 6$

B $y = -x^2 - 2x + 6$

C $y = -2x^2 - x + 6$

D $y = 2x^2 - 5x + 6$

Correct Response: **D**

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Depth-of-Knowledge: 2

Which of these observations would be consistent with an exponential model of population growth?

A The population started out large, decreased in size, then became large again.

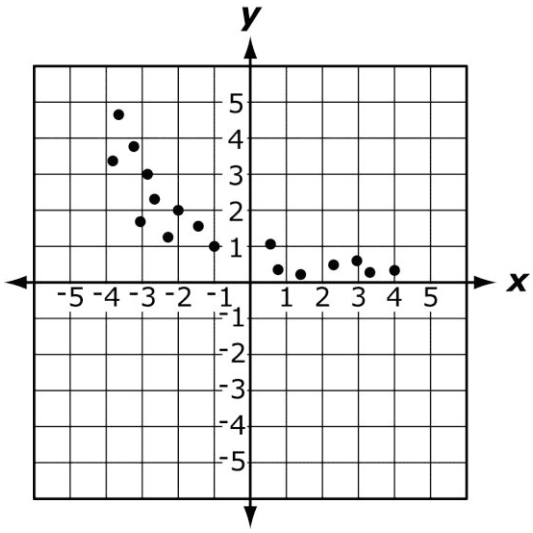
B The population is observed to increase at a faster rate as time passes.

C The population is observed to increase steadily over time.

D The population grew very quickly but then declined.

Correct Response: **B**

Depth-of-Knowledge: 3



Which equation <u>best</u> models the data in this scatter plot?

A $y = 5(0.5^x)$

B $y = -5(5^x)$

C $y = 0.5(0.5^x)$

D $y = -0.5(5^x)$

Correct Response: **C**

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OAS:

Standard 3: Data Analysis and Statistics

Oklahoma Academic Objective:

*Objective 3.2: Measures of Central Tendency and Variability

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*Assessed at the local level.

OAS:

Standard 3: Data Analysis and Statistics

Oklahoma Academic Objective:

Objective 3.3: Identify and use arithmetic and geometric sequences and series to solve problems.

Item Specifications:

Emphasis:

- The student will use arithmetic and geometric sequences and series to formulate and justify predictions from a set of data.

Stimulus Attributes:

- Test items may include context, equations, arithmetic, and geometric sequences and series.
- The following formula box will be displayed:

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

Format:

- Identify the *n*th term in an arithmetic or geometric sequence.
- Identify the sum of an arithmetic or geometric series.
- Identify mathematical and real-world situations that can be represented by specific algebraic expressions and equations.

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Content Limits:

- Limit real-life and mathematical contexts to age-appropriate situations.

Primary Process Standards:

- Problem Solving
- Connections

Distractor Domain:

- Common algebraic misconceptions
- Misconceptions of arithmetic and geometric sequences and series
- Interchange of arithmetic and geometric sequences and series

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Depth-of-Knowledge: 1

{**1, 3, 5, 7, . . .**}

What is the 12th term in this sequence?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A 22
B 23
C 24
D 25

Correct Response: **B**

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Depth-of-Knowledge: 2

$$\mathbf{2 + 10 + 50 + \ldots}$$

What is the sum of the first 6 terms of this series?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A 3,906

B 7,812

C 15,624

D 31,248

Correct Response: **B**

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Depth-of-Knowledge: 2

A child puts $1.00 into a piggy bank. One week later, he puts $1.25 in the bank. Two weeks later, he puts $1.50 in the bank, and so on. How much money does he put in the bank on the 25th week?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A $6.75

B $7.00

C $93.00

D $100.00

Correct Response: **B**

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Depth-of-Knowledge: 2

What is the value of *x* in the geometric sequence $\left\{x, \frac{-1}{2}, \frac{1}{8}, \frac{-1}{32}, \ldots\right\}$?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A -4

B -2

C 2

D $\frac{9}{2}$

Correct Response: **C**

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Depth-of-Knowledge: 3

In an arithmetic sequence beginning with 36 and ending with 405, how many integers are divisible by 9?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A 41 integers

B 42 integers

C 44 integers

D 45 integers

Correct Response: **B**

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Depth-of-Knowledge: 3

How many terms are there in a geometric series if the first term is 3, the common ratio is 4, and the sum of the series is 1,023?

Arithmetic Sequences & Series

n^{th} term: $a_n = a_1 + (n-1)d$

Sum: $s_n = \frac{n}{2}(a_1 + a_n)$

Geometric Sequences & Series

n^{th} term: $a_n = a_1 r^{(n-1)}$

Sum: $s_n = \frac{a_1(1-r^n)}{(1-r)}$

A 4 terms

B 5 terms

C 6 terms

D 23 terms

Correct Response: **B**

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