Task Model 1

Response Type: Multiple Choice, single correct response

DOK Level 1

N-RN.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required:

1. The student rewrites expressions in radical form into an equivalent expression with rational exponents.

Tools: None

Prompt Features: Given an expression in radical form, identify an equivalent expression in exponent form.

Stimulus Guidelines:

- For radicals (e.g., $\sqrt[q]{p^r}$) p may be either a number (except 0 or 1), or a variable.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - Expressions can be given in $\sqrt[q]{p^r}$ form where p is a number (except 0 or 1).
    - Expressions can be given in $\sqrt[q]{p^r}$ form where p is a variable.
    - Expressions can be given in $\sqrt[q]{p^{\frac{s}{r}}}$ form where p is a number (except 0 or 1), or a variable.

TM1a

Stimulus: The student will be presented with an expression of the form $\sqrt[q]{p^r}$.

Example Stem: Select an expression that is equivalent to $\sqrt[9]{3^6}$.

A. $3^{\frac{2}{3}}$
B. $3^{\frac{3}{2}}$
C. 3^3
D. 3^{15}

Rubric: (1 point) The student correctly selects the equivalent rational form (e.g., A).

TM1b

Stimulus: The student will be presented with an expression of the form $\sqrt[q]{p^{\frac{s}{r}}}$.

Example Stem: Select an expression that is equivalent to $\sqrt[4]{x^{\frac{2}{3}}}$.

A. $x^{\frac{1}{4}}$
B. $x^{\frac{9}{4}}$
C. $x^{\frac{1}{6}}$
D. $x^{\frac{8}{3}}$

Rubric: (1 point) The student correctly selects the equivalent rational form (e.g., C).

Response Type: Multiple Choice, single correct response

Task Model 2

Response Type:

Multiple Choice, single correct response

DOK Level 1

N-RN.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required:
2. The student will be able to rewrite expressions with rational exponents into an equivalent expression in radical form.

Tools: None

Prompt Features: Given an expression in rational form, identify an equivalent expression in radical form.

Stimulus Guidelines:

- For rational exponents (e.g., $p^{\frac{r}{q}}$) *p* may be either:
  - a number (except 0 or 1), or
  - a multi-term expression, or
  - a variable with an integer coefficient.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - Expressions can be given as $p^{\frac{r}{q}}$ where *p* is a number (except 0 or 1).
  - Expressions can be given as $p^{\frac{r}{q}}$ where *p* is a variable that may or may not have an integer coefficient.

TM2a
Stimulus: The student will be presented with an expression of the form $p^{\frac{r}{q}}$.

Example Stem: Select an expression that is equivalent to $3^{\frac{6}{9}}$.

A. $\sqrt[9]{3^6}$
B. $\sqrt[6]{3^9}$
C. $\sqrt{3^3}$
D. $\sqrt[3]{3}$

Rubric: (1 point) The student correctly selects the equivalent radical form (e.g. A).

Response Type: Multiple Choice, single correct response

Task Model 2

Response Type: Matching Tables

DOK Level 1

N-RN.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required: 2. The student will be able to rewrite expressions with rational exponents into an equivalent expression in radical form.

Tools: None

Prompt Features: Given an expression in rational form, identify an equivalent expression in radical form.

Stimulus Guidelines:

- For rational exponents (e.g., $p^{\frac{r}{q}}$) *p* may be either:
    - a number (except 0 or 1), or
    - a multi-term expression, or
    - a variable with an integer coefficient.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - Expressions can be given as $p^{\frac{r}{q}}$ where *p* is a number (except 0 or 1).
    - Expressions can be given as $p^{\frac{r}{q}}$ where *p* is a variable that may or may not have an integer coefficient.

TM2b

Stimulus: The student will be presented with an expression of the form $p^{\frac{r}{q}}$.

Example Stem 1: Determine whether each expression is equivalent to $x^{\frac{5}{3}}$. Select Yes or No for each expression.

	Yes	No
$\sqrt{x}$		
$\sqrt[3]{x^5}$		
$\sqrt[5]{x^3}$		
$\sqrt{x^{\frac{5}{3}}}$		

Example Stem 2: Determine whether each expression is equivalent to $(2x^3)^{\frac{2}{5}}$. Select Yes or No for each expression.

	Yes	No
$\sqrt[5]{4x^6}$		
$x\sqrt[5]{4}$		
$\sqrt[5]{2x^6}$		
$x\sqrt[5]{4x}$		
$\sqrt[5]{4x^3}$		

Rubric: (1 point) The student correct identifies the equivalent expression(s) (e.g. NYNN; YNNYN)

Response Type: Matching Tables

Task Model 3

Response Type:

Multiple Choice, single correct response

DOK Level 1

N-RN.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required:
3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.

Tools: None

Prompt Features: Given an expression in radical form, identify an equivalent expression in exponent form.

Stimulus Guidelines:

- For radicals (e.g., $\sqrt[q]{p^r}$, $\sqrt[q]{p^r}$, $\sqrt[t]{p^s}$), for rational exponents (e.g., $p^{\frac{r}{q}}$, $p^{\frac{s}{t}}$, $p^{\frac{m}{n}}$) and for complex expressions (e.g., $p^{\frac{r}{q}}(\sqrt[t]{p^s} + p^m)$; $\sqrt[q]{p^{\frac{r}{n}}}$; $\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}}$, $\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}}$) *p* may be either:
    - a number (except 0 or 1), or
    - a multi-term expression, or
    - a variable with an integer coefficient, provided that there are no other variables in the expression.
- For rational exponents, *n, q,* or *t* may be a variable provided that the corresponding *m, r,* or *s* is the same variable.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - *p* can be a number (except 0 or 1), or equation is in $\sqrt[q]{p^{\frac{r}{m}}} = p^{\frac{s}{t}}$ form with one variable.
    - *p* can be a number (except 0 or 1) or a variable with or without an integer coefficient, or equation is in $\sqrt[q]{p^r} \cdot \sqrt[t]{p^s} = p^{\frac{m}{n}}$, or $p^{\frac{r}{q}} \cdot p^{\frac{s}{t}} = \sqrt[n]{p^m}$ form with one variable.
    - Equations can be in $\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}} = \sqrt[n]{p^m}$, or $\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}} = p^{\frac{m}{n}}$ form with one variable, or answer choices are in exponent form.

TM3a
Stimulus: The student will be presented with an expression in the form $\sqrt[q]{p^r} \cdot \sqrt[t]{p^s}$.

Example Stem 1 : Select an expression that is equivalent to $\sqrt[4]{4^2} \cdot \sqrt[4]{4^3}$.

A. $4^{\frac{4}{5}}$
B. $4^{\frac{4}{6}}$
C. $4^{\frac{5}{4}}$
D. $4^{\frac{6}{4}}$

Example Stem 2: Select an expression that is equivalent to $\sqrt[4]{2x^2} \cdot \sqrt[4]{2x^3}$.

A. $2^{\frac{1}{2}}x^{\frac{6}{2}}$
B. $2^{\frac{2}{4}}x^{\frac{5}{4}}$
C. $4^{\frac{1}{3}}x^{\frac{5}{2}}$
D. $4^{\frac{4}{2}}x^{\frac{1}{4}}$

Rubric: (1 point) The student correctly selects the equivalent rational form (e.g., C; B).

Response Type: Multiple Choice, single correct response

Task Model 3

Response Type:

Multiple Choice, single correct response

DOK Level 1

N-RN.2
Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required:
3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.

Tools: None

Prompt Features: Given an expression in rational form, identify an equivalent expression in radical form.

Stimulus Guidelines for TM3b and TM3c: same as for TM3a

TM3b
Stimulus: The student will be presented with an expression in the form $p^{\frac{r}{q}} \cdot p^{\frac{s}{t}}$.

Example Stem 1: Select an expression that is equivalent to $16^{\frac{1}{4}} \cdot 16^{\frac{2}{3}}$.

A. $\sqrt[12]{16^{11}}$
B. $\sqrt[7]{16^3}$
C. $\sqrt[12]{16^2}$
D. $\sqrt[6]{16^4}$

Example Stem 2: Select an expression that is equivalent to $\left(\frac{1}{3}\right)x^{\frac{1}{4}} \cdot \left(\frac{1}{3}\right)x^{\frac{2}{3}}$.

A. $\sqrt[12]{3x^2}$
B. $\sqrt[6]{\left(\frac{1}{3}\right)x^4}$
C. $\frac{1}{9}\sqrt[12]{x^{11}}$
D. $\frac{1}{3}\sqrt[12]{x^2}$

Rubric: (1 point) The student correctly selects the equivalent radical form (e.g., A; C).

TM3c
Stimulus: The student will be presented with an expression of the form $p^{\frac{r}{q}}(\sqrt[t]{p^s} + p^m)$.

Example Stem: Select an expression that is equivalent to $8^{\frac{1}{3}}(\sqrt[3]{8^2} + 8^2)$.

A. $\sqrt{8^9} + 8^{\frac{3}{7}}$
B. $\sqrt[3]{8^3} + 8^{\frac{7}{3}}$
C. $\sqrt[7]{8^3} + 8^{\frac{3}{2}}$
D. $\sqrt[9]{8^2} + 8^{\frac{7}{3}}$

Rubric: (1 point) The student correctly selects the equivalent radical form (e.g., C).

Response Type: Multiple Choice, single correct response

Task Model 3

Response Type:
Equation/Numeric

DOK Level 2

N-RN.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Evidence Required:
3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.

Tools: None

Prompt Features: Solve for a variable that will create equivalent expressions with radicals and rational exponents.

Stimulus Guidelines:

- For radicals (e.g., $\sqrt[q]{p^r}$, $\sqrt[q]{p^r}$, $\sqrt[t]{p^s}$), for rational exponents (e.g., $p^{\frac{r}{q}}$, $p^{\frac{s}{t}}$, $p^{\frac{m}{n}}$) and for complex expressions (e.g., $p^{\frac{r}{q}}(\sqrt[t]{p^s}+p^m)$; $\sqrt[q]{p^{\frac{\mathrm{r}}{n}}}$; $\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}}$, $\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}}$) *p* may be either:
    - a number (except 0 or 1), or
    - a multi-term expression, or
    - a variable with an integer coefficient, provided that there are no other variables in the expression.
- For rational exponents, *n, q,* or *t* may be a variable provided that the corresponding *m, r,* or *s* is the same variable.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - *p* can be a number (except 0 or 1), or equation is in $\sqrt[q]{p^{\frac{\mathrm{r}}{m}}} = p^{\frac{s}{t}}$ form with one variable.
    - *p* can be a number (except 0 or 1) or a variable with or without an integer coefficient, or equation is in $\sqrt[q]{p^r} \cdot \sqrt[t]{p^s} = p^{\frac{m}{n}}$, or $p^{\frac{r}{q}} \cdot p^{\frac{s}{t}} = \sqrt[n]{p^m}$ form with one variable.
    - Equations can be in either $\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}} = \sqrt[n]{p^m}$, or $\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}} = p^{\frac{m}{n}}$ form.
    - Answer choices can be in radical form.

TM3d
Stimulus: The student will be presented with an equation of the form $\sqrt[q]{p^{\frac{\mathrm{r}}{m}}} = p^{\frac{s}{t}}$.

- *m, q, r, s, or t* may be replaced with a variable.

Example Stem: Enter the value of *x* such that $\sqrt[4]{64^{\frac{1}{3}}} = 64^{\frac{1}{x}}$ is true.

Rubric:
(1 point) The student enters the correct value of the variable (e.g., 12).

Response Type: Equation/Numeric

Task Model 3 **Response Type:** **Equation/Numeric** **DOK Level 2** **N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. **Evidence Required:** 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents. **Tools:** None	**Prompt Features:** Solve for a variable that will create equivalent expressions with radicals and rational exponents. **Stimulus Guidelines for TM3e-h:** same as for TM3d **TM3e** **Stimulus:** The student will be presented with an equation in the form $\sqrt[q]{p^r}\cdot\sqrt[t]{p^s}=p^{\frac{m}{n}}$. • *m, n, q, r, s, or t* may be replaced with a variable. **Example Stem:** Enter the value of *x* such that $\sqrt[3]{27^2}\cdot\sqrt[3]{27^5}=27^{\frac{x}{3}}$ is true. **Rubric:** (1 point) The student enters the correct value of the variable (e.g., 7). **Response Type:** Equation/Numeric **TM3f** **Stimulus:** The student will be presented with an equation in the form $p^{\frac{r}{q}}\cdot p^{\frac{s}{t}}=\sqrt[n]{p^m}$. • *m, n, q, r, s, or t* may be replaced with a variable. **Example Stem:** Enter the value of *x* such that $3^{\frac{4}{5}}\cdot 3^{\frac{3}{x}}=\sqrt[5]{3^7}$ is true. **Rubric:** (1 point) The student enters the correct value of the variable (e.g., 5). **TM3g** **Stimulus:** The student will be presented with an equation of the form $\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}}=\sqrt[n]{p^m}$. • *m, n, q, r, s,* or *t* may be replaced with a variable. **Example Stem:** Enter the value of *x* such that $\frac{16^{\frac{5}{4}}}{16^{\frac{1}{x}}}=\sqrt[3]{16^3}$ is true. **Rubric:** (1 point) The student enters the correct value of the variable. (e.g., 4). **Response Type:** Equation/Numeric

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 2** **N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. **Evidence Required:** 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents. **Tools:** None	**Prompt Features:** Solve for a variable that will create equivalent expressions with radicals and rational exponents. **TM3h** **Stimulus:** The student will be presented with an equation of the form $\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}} = p^{\frac{m}{n}}$. • *m, n, q, r, s,* or *t* may be replaced with a variable. **Example Stem:** Enter the value of *x* such that $\frac{4^{\frac{3}{2}}}{\sqrt[8]{4^4}} = 4^{\frac{x}{2}}$ is true. **Rubric:** (1 point) The student enters the correct value of the variable (e.g., 2). **Response Type:** Equation/Numeric

Task Model 3 **Response Type:** **Multiple Choice, single correct response** **DOK Level 2** **N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. **Evidence Required:** 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents. **Tools:** None	**Prompt Features:** Solve for a variable that will create equivalent expressions with radicals and rational exponents. **Stimulus Guidelines:** same as for TM3d **TM3i** **Stimulus:** The student will be presented with an expression of the form $p^{\frac{r}{q}} \cdot \sqrt[t]{p^s}$. **Example Stem 1:** Select an expression that is equivalent to $5^{\frac{3}{8}} \cdot \sqrt[4]{5^2}$. A. $5^{\frac{6}{32}}$ B. $5^{\frac{5}{12}}$ C. $5^{\frac{12}{16}}$ D. $5^{\frac{7}{8}}$ **Example Stem 2:** Select an expression that is equivalent to $y^{\frac{3}{8}} \cdot \sqrt[4]{y^2}$. A. $y^{\frac{6}{32}}$ B. $y^{\frac{5}{12}}$ C. $y^{\frac{12}{16}}$ D. $y^{\frac{7}{8}}$ **Example Stem 3:** Select an expression that is equivalent to $5^{\frac{3}{8}} \cdot \sqrt[4]{5^3}$. A. $\sqrt[8]{5^9}$ B. $\sqrt[32]{5^9}$ C. $\sqrt[12]{5^7}$ D. $5\sqrt[7]{5^5}$ **Rubric:** (1 point) The student correctly selects the equivalent rational or radical form (e.g., D; D; A). **Response Type:** Multiple Choice, single correct response

Task Model 1

Response Type:
Hot Spot

DOK Level 2

N-RN.3

Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
1. The student provides examples of addition or multiplication problems that will have sums or products of a specified type (rational or irrational).

Tools: None

Prompt Features: The student gives an example of either an addition or multiplication problem with either a rational or irrational product or sum.

Stimulus Guidelines:

- Four or more numbers are given, of which
  - two are rational numbers and
  - two are irrational numbers.
- The irrational numbers can be π or of the form $a\sqrt[n]{b}$ where:
  - a is rational;
  - b is an integer such that
    - b is positive when n is even, and
    - b may be negative when n is odd; and
  - n is an whole number such that $2 \leq n \leq 9$.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - radicands lead to roots that do or do not simplify to rational numbers
  - sum/product of the radicands does or does not lead to roots that simplify to a rational number
  - integer or fraction coefficients may be added in front of the radicals
  - radicands can be whole numbers or fractions

TM1
Stimulus: The student is presented with rational and irrational numbers.

Example Stem 1: Click on **two** numbers whose sum, when added, would be **irrational**.

Numbers	-5	$3\sqrt{2}$	$\frac{2}{3}$	$\frac{1}{3}$	$\sqrt{8}$

Example Stem 2: Click on **two** numbers whose sum, when added, would be **rational**.

Numbers	-5	$3\sqrt{2}$	$\frac{2}{3}$	$\frac{1}{3}$	$\sqrt{7}$

Example Stem 3: Click on **two** numbers whose product, when multiplied, would be **irrational**.

Numbers	-5	$3\sqrt{2}$	$\frac{2}{3}$	$\frac{1}{3}$	$\sqrt{8}$

Task Model 1

Response Type:
Hot Spot

DOK Level 2

N-RN.3
Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
1. The student provides examples of addition or multiplication problems that will have sums or products of a specified type (rational or irrational).

Tools: None

Example Stem 4: Click on **two** numbers whose product, when multiplied, would be **rational**.

Numbers	-5	$3\sqrt{2}$	$\frac{2}{3}$	$\frac{1}{3}$	$\sqrt{8}$

Rubric:
(1 point) The student selects two numbers that satisfy the given conditions. Multiple correct responses are possible and will all need to be included in the scoring rubric. Only example responses are shown below.

Example Stem 1:

Numbers	-5	$3\sqrt{2}$	$\frac{2}{3}$	[✓ $\frac{1}{3}$]	[✓ $\sqrt{8}$]

Example Stem 2:

Numbers	[✓ -5]	$3\sqrt{2}$	$\frac{2}{3}$	[✓ $\frac{1}{3}$]	$\sqrt{7}$

Example Stem 3:

Numbers	-5	[✓ $3\sqrt{2}$]	$\frac{2}{3}$	[✓ $\frac{1}{3}$]	$\sqrt{8}$

Example Stem 4:

Numbers	-5	$3\sqrt{2}$	[✓ $\frac{2}{3}$]	[✓ $\frac{1}{3}$]	$\sqrt{8}$

Response Type: Hot Spot

Task Model 2

Response Type:
Matching Tables

DOK Level 2

N-RN.3

Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
2. The student determines whether the sum of two numbers is a rational number or an irrational number.

Tools: None

Prompt Features: The student is presented with a list of expressions that contain the sums of rational and/or irrational terms.

Stimulus Guidelines:

- Answer choices include 5 or 6 sums.
- Irrational numbers can be π or of the form $a\sqrt[n]{b}$ where:
  - a is rational;
  - b is an integer such that
    - b is positive when n is even, and
    - b may be negative when n is odd; and
  - n is an whole number such that $2 \leq n \leq 9$.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - radicands lead to roots that do/do not simplify to rational numbers;
  - sum/product of the radicands does/does not lead to roots that simplify to a rational number;
  - integer or fraction coefficients may be added in front of the radicands;
  - radicands can be whole numbers or fractions;

TM2a
Stimulus: The student is presented with a list of expressions that contain the sums of rational and/or irrational terms.

Example Stem: Select the appropriate box to identify each expression as having either a rational or irrational sum.

	Rational	Irrational
$5\sqrt{7} + \frac{1}{7}$		
$\sqrt{4} + 17$		
$12.4 + (-11)$		
$-\frac{4}{5} + (-10\sqrt{10})$		

Rubric: (1 Point) The student correctly identifies the sum as rational or irrational (e.g., Irrational, Rational, Rational, Irrational).

Task Model 2

Response Type:
Matching Tables

DOK Level 2

N-RN.3
Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
2. The student determines whether the sum of two numbers is a rational number or an irrational number.

Tools: None

TM2b
Stimulus: The student is presented with a table of numbers.

Example Stem: Select each box in the table where the numbers from corresponding rows and columns will have a **rational** sum.

	4	$\frac{1}{3}$	$\sqrt{3}$	π
4				
$\frac{1}{3}$				
$\sqrt{3}$				
π				

Rubric: (1 Point) The student correctly identifies the sum as rational or irrational (e.g., see below).

	4	$\frac{1}{3}$	$\sqrt{3}$	π
4	▨	▨		
$\frac{1}{3}$	▨	▨		
$\sqrt{3}$				
π				

Response Type: Matching Tables

Task Model 3

Response Type:
Matching Tables

DOK Level 2

N-RN.3
Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
3. The student determines whether the product of two numbers is a rational number or an irrational number.

Tools: None

Prompt Features: The student is prompted to identify products as rational or irrational.

Stimulus Guidelines:

- The irrational numbers can be π or of the form $a\sqrt[n]{b}$ where:
  - a is rational;
  - b is an integer such that
    - b is positive when n is even, and
    - b may be negative when n is odd; and
    - n is an whole number such that $2 \leq n \leq 9$.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - radicands lead to roots that do/do not simplify to rational numbers;
  - sum/product of the radicands does/does not lead to roots that simplify to a rational number;
  - integer or fraction coefficients may be added in front of the radicands;
  - radicands can be whole numbers or fractions.

TM3a
Stimulus: The student is presented with a list of expressions that contain the product of rational and/or irrational terms.

Example Stem: Select the appropriate box to identify each expression as having either a rational or irrational product.

	Rational	Irrational
$5\sqrt{7}\cdot\frac{1}{7}$		
$\sqrt{4}\cdot 17$		
$12.4\cdot(-11)$		
$-\frac{4}{5}\cdot(-10\sqrt{10})$		

Rubric: (1 Point) The student correctly identifies the product as rational or irrational (e.g., Irrational, Rational, Rational, Irrational).

Task Model 3

Response Type:
Matching Tables

DOK Level 2

N-RN.3
Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
3. The student determines whether the product of two numbers is a rational number or an irrational number.

Tools: None

TM3b
Stimulus: The student is presented with a table of numbers.

Example Stem: Select each box in the table where the numbers from corresponding rows and columns will have a rational product.

	4	$\frac{1}{3}$	$\sqrt{3}$	$-\sqrt{3}$
4				
$\frac{1}{3}$				
$\sqrt{3}$				
$-\sqrt{3}$				

Rubric: (1 Point) The student correctly identifies the product as rational or irrational (e.g., see below).

	4	$\frac{1}{3}$	$\sqrt{3}$	$-\sqrt{3}$
4	▨	▨		
$\frac{1}{3}$	▨	▨		
$\sqrt{3}$			▨	▨
$-\sqrt{3}$			▨	▨

Response Type: Matching Tables

Task Model 3

Response Type:

Multiple Choice, single correct response

DOK Level 1

N-RN.3

Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
3. The student determines whether the product of two numbers is a rational number or an irrational number.

Tools: None

Prompt Features: Identify which factors would result in a rational product when multiplied by a given a rational or irrational number.

Stimulus Guidelines:

- The irrational numbers can be π or of the form $a\sqrt[n]{b}$ where:
    - a is rational;
    - b is an integer such that
        - b is positive when n is even, and
        - b may be negative when n is odd; and
        - n is an whole number such that $2 \leq n \leq 9$.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - radicands lead to roots that do/do not simplify to rational numbers;
    - sum/product of the radicands does/does not lead to roots that simplify to a rational number;
    - integer or fraction coefficients may be added in front of the radicands;
    - radicands can be whole numbers or fractions.

TM3c
Stimulus: The student is presented with a rational or irrational number.
Example Stem: Select **all** numbers that will produce a **rational** number when multiplied by $7\sqrt{5}$.

A. $-\frac{1}{5}$
B. $7\sqrt{125}$
C. $5+\sqrt{5}$
D. $3\sqrt{\frac{9}{5}}$

Rubric: (1 point) The student correctly identifies the products as rational (e.g., B, D).

Response Type: Multiple Choice, multiple correct response

Task Model 3

Response Type:
Matching Tables

DOK Level 1

N-RN.3

Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Evidence Required:
2. The student determines whether the sum of two numbers is a rational number or an irrational number.

3. The student determines whether the product of two numbers is a rational number or an irrational number.

Tools: None

Prompt Features: The student will be prompted to identify sums and products as rational or irrational.

Stimulus Guidelines:

- The irrational numbers can be π or of the form $a\sqrt[n]{b}$ where:
    - a is rational;
    - b is an integer such that
        - b is positive when n is even, and
        - b may be negative when n is odd; and
    - n is an whole number such that $2 \leq n \leq 9$.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - radicands lead to roots that do/do not simplify to rational numbers;
    - sum/product of the radicands does/does not lead to roots that simplify to a rational number;
    - integer or fraction coefficients may be added in front of the radicands;
    - radicands can be whole numbers or fractions.

TM3d
Stimulus: The student is presented with expressions that contain the sums and products of rational and/or irrational terms.

Example Stem: Select the appropriate box to identify the value of each expression as being rational or irrational.

	Rational	**Irrational**
$5\sqrt{7} + \frac{1}{7}$		
$12.4 \cdot (-11)$		
$\sqrt{4} + 17$		
$\left(-10\sqrt{10}\right) \cdot 10\sqrt{10}$		

Rubric: (1 Point) Student correctly identifies all sums and products correctly (e.g., Irrational, Rational, Rational, Rational).

Response Type: Matching Tables

Task Model 1

Response Type: Multiple Choice, single correct response

DOK Level 1

N-Q.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Evidence Required:
1. The student chooses units consistently in formulas.

Tools: Calculator

Prompt Features: The student is prompted to choose the units of measurement in formulas.

Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but is not limited to these methods:

- One step problems, such as finding units for *V* in $V = \frac{d}{t}$, given units for *d* and *t*.
- Two- or three-step problems, such as finding units for *E* in $E = mc^2$, given units for *m* and *c*.
- Three or more step problems, where not all units are given for all variables.
- Problems where units are calculated for a variable in one equation in order to find units for a variable in another given equation in context where units may not be familiar.

TM1a
Stimulus: The student is presented with a formula that uses measurements given in different units.

Example Stem: Given the formula, $K = \frac{1}{2}mv^2$ where

- *K* represents kinetic energy,
- *m* represents mass and has units of kilograms (*kg*), and
- *v* represents velocity and has units of meters per second (*m/s*).

Select an appropriate measurement unit for kinetic energy.

A. $\frac{kg\ m^2}{s}$

B. $\frac{kg^2\ m^2}{s^2}$

C. $\frac{kg\ m}{s^2}$

D. $\frac{kg\ m^2}{s^2}$

Rubric: (1 point) Student selects the correct response (e.g., D).

Response Type: Multiple Choice, single correct response

Task Model 1

Response Type:
Drag and Drop

DOK Level 1

N-Q.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Evidence Required:
1. The student chooses units consistently in formulas.

Tools: Calculator

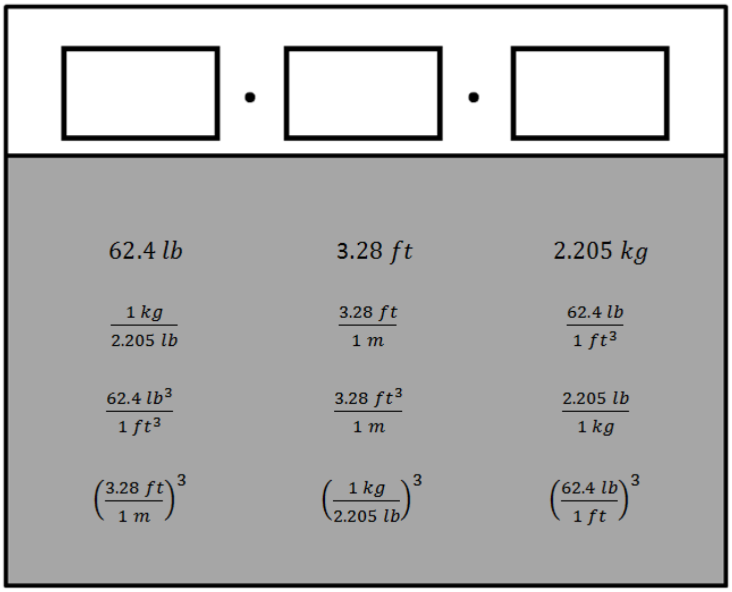
Prompt Features: The student is prompted to choose the units of measurement in formulas.

Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but are not limited to these methods:
- Two step problems
- Three or more step problems

TM1b
Stimulus: The student is presented with a context in which a number needs converting of units.

Example Stem: The density of water at a certain temperature is $62.4\ \frac{lb}{ft^3}$.

Drag a rate or quantity from the box to each blank to calculate the density of water in units of kilograms per cubic meter, $\frac{kg}{m^3}$.



☐ • ☐ • ☐

$62.4\ lb$	$3.28\ ft$	$2.205\ kg$
$\frac{1\ kg}{2.205\ lb}$	$\frac{3.28\ ft}{1\ m}$	$\frac{62.4\ lb}{1\ ft^3}$
$\frac{62.4\ lb^3}{1\ ft^3}$	$\frac{3.28\ ft^3}{1\ m}$	$\frac{2.205\ lb}{1\ kg}$
$\left(\frac{3.28\ ft}{1\ m}\right)^3$	$\left(\frac{1\ kg}{2.205\ lb}\right)^3$	$\left(\frac{62.4\ lb}{1\ ft}\right)^3$

Interaction: The student drags and drops the correct rate or quantify from the box in order to calculate the density of water in $\frac{kg}{m^3}$.

Rubric: (1 point) The student chooses the following correct three rates or quantities (order does not matter): $\frac{62.4\ lb}{1\ ft^3}$, $(\frac{3.28\ ft}{1\ m})^3$, $\frac{1\ kg}{2.205\ lb}$
One such ordering would be: $\frac{62.4\ lb}{1\ ft^3} \bullet (\frac{3.28\ ft}{1\ m})^3 \bullet \frac{1\ kg}{2.205\ lb}$.

Response Type: Drag and Drop

Task Model 2

Response Type: Matching Tables

DOK Level 2

N-Q.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Evidence Required:
2. The student chooses the scales for graphs and data displays.

Tools: Calculator

Prompt Features: The student is prompted to choose the graphing window for a graph.

Stimulus Guidelines: Item difficulty can be adjusted by using different types of functions (e.g., linear, quadratic, etc.)

- Asking students to identify windows where certain key features would be visible.

TM2a
Stimulus: The student is presented with a contextual situation where the equation for the function may or may not be given.

Example Stem: A company makes 3,000 liters of juice per day. Let *y* represent the total amount of juice, in liters, made in *x* days.

An equation representing this situation is entered into a graphing calculator. Determine whether a graph created with each calculator display window defined in the table will show all points representing the total amount of juice made in 0 to 7 days.

Select Yes or No for each display window.

The calculator display window shows:	Yes	No
$-100 \le x \le 3{,}100$ and $-1 \le y \le 8$		
$-1 \le x \le 8$ and $-100 \le y \le 3{,}100$		
$-1 \le x \le 8$ and $-100 \le y \le 21{,}100$		
$-100 \le x \le 21{,}100$ and $-100 \le y \le 3{,}100$		

Rubric: (1 point) The student selects the correct response for each display window (e.g., NNYN).

Response Type: Matching Tables

Task Model 2

Response Type: Multiple Choice, multiple correct response

DOK Level 2

N-Q.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Evidence Required:
2. The student chooses the scales for graphs and data displays.

Tools: Calculator

Prompt Features: The student is prompted to select the fewest quadrants needed to create a graph.

Stimulus Guidelines: The student is presented with a contextual situation.

- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - graph fits into one quadrant
  - graph fits into more than one quadrant

TM2b
Stimulus: The student is presented with a contextual situation.

Example Stem 1: Pedro has \$200 saved. He saves an average of \$45 per week.

Select as few quadrants as possible that would allow you to create a graph of Pedro's savings, *y*, after *x* weeks.

A. Quadrant 1
B. Quadrant 2
C. Quadrant 3
D. Quadrant 4

Example Stem 2: Carla borrowed \$18,000 to start a business. Her business earnings averaged \$350 per week for the first 10 weeks. Her earnings averaged \$500 for the next 10 weeks. Carla's balance, *y*, in any week, *x*, is equal to her total earnings minus the amount she borrowed.

Select as few quadrants as possible that would allow you to create a graph of Carla's balance over the first 20 weeks.

A. Quadrant 1
B. Quadrant 2
C. Quadrant 3
D. Quadrant 4

Rubric: (1 point) The student selects the correct responses (e.g., A; D).

Response Type: Multiple Choice, multiple correct response

Task Model 1

Response Type: Multiple Choice, single correct response

DOK Level 1

A-SSE.2
Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$, *thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Evidence Required:
1. The student uses the structure of an expression to identify ways of rewriting it.

Tools: None

Prompt Features: The student is prompted to use the structure of an expression to select the expression that is equivalent to the given expression.

Stimulus Guidelines:

- Expressions may be:
  - difference of two squares
  - sum/difference of two cubes
  - the product of two or three expressions
  - sum/difference of expressions that have a common factor
  - rational
  - exponential
- Difficulty level can be altered by varying the type of expression and/or the order of factors in a compound expression, and by using different variables and coefficients.

TM1a
Stimulus: The student is presented with an expression that is a difference of two squares.

Example Stem: Select the expression that is equivalent to $x^2 - 4$.

A. $(x-2)^2$
B. $(x-2)(x+2)$
C. $x^2 + 2x + 4$
D. $x^2 - 2x + 4$

Rubric: (1 point) The student selects the correct option (e.g., B).

Response Type: Multiple Choice, single correct response

TM1b
Stimulus: The student is presented with an expression that is the sum/difference of expressions that have a common factor.

Example Stem: Select the expression that is equivalent to $(x+4)^2 - (x-2)(x+4)$.

A. $4(x+4)$
B. $2(x+1)(x+4)$
C. $(x+4) - (x-2)$
D. $(x+4)[(x+4) - (x-2)]$

Rubric: (1 point) The student selects the correct option (e.g., D).

Response Type: Multiple Choice, single correct response

Task Model 1

Response Type:
Matching Tables

DOK Level 1

A-SSE.2
Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Evidence Required:
1. The student uses the structure of an expression to identify ways of rewriting it.

Tools: None

TM1c

Stimulus: The student is presented with an expression that is a sum/difference of two cubes.

Example Stem 1: Determine whether each expression is equivalent to $(x^3 + 8)$. Select Yes or No for each expression.

	Yes	No
$(x+2)^3$		
$(x-2)(x^2+2x+4)$		
$(x+2)(x^2-2x+4)$		

Example Stem 2: Determine whether each expression is equivalent to $(8x^3 - 64)$. Select Yes or No for each expression.

	Yes	No
$(2x-4)^3$		
$8(x-8)^3$		
$8(x-2)(x^2+2x+4)$		
$(2x-4)(4x^2+8x+16)$		

Rubric: (1 point) The student selects the correct options (e.g., NNY; NNYY).

Response Type: Matching Tables

Task Model 1

Response Type:
Matching Tables

DOK Level 2

A-SSE.2
Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Evidence Required:
1. The student uses the structure of an expression to identify ways of rewriting it.

Tools: None

Prompt Features: The student is prompted to use the structure of expressions to determine if two expressions are equivalent.

Stimulus Guidelines:

- Equivalences consist of equations of expressions, which may involve:
  - difference of two squares
  - sum/difference of two cubes
  - the product of two or three expressions
  - sum/difference of expressions that have a common factor
  - rational expressions
  - exponential expressions
- Difficulty level can be altered by varying the type of expression and/or the order of factors in an equation, and by using different variables and coefficients.

TM1d
Stimulus: The student is presented with four equations.

Example Stem 1: Determine if each equation is true for all values of *x*. Select Yes or No for each equation.

	Yes	No
$x^2 + 4 = (x + 2)^2$		
$(2x + 6)^2 = 4(x + 3)^2$		
$(x - 3)(x - 3) = (x - 9)^2$		
$x^2 - 10x + 25 = (x - 5)(x + 5)$		

Example Stem 2: Determine if each equation is true for all values of *x*. Select Yes or No for each equation.

	Yes	No
$2^{3x} = 6^x$		
$100^x = 10^{2x}$		
$e^x.e^x = e^{2x}$		
$2^{10x} = 10^{2x}$		

Rubric: (1 point) The student selects the correct options (e.g., NYNN; NYYN).

Response Type: Matching Tables

Task Model 1

Response Type: Drag and Drop

DOK Level 2

A-SSE.2
Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$, *thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Evidence Required:
1. The student uses the structure of an expression to identify ways of rewriting it.

Tools: None

Prompt Features: The student is prompted to use the structure of a rational expression to create an expression that is equivalent to the given expression.

Stimulus Guidelines:

- Equivalences consist of equations of rational expressions.
- Difficulty level can be altered by varying the complexity of the equations, the type of rational expressions, and by using different variables and coefficients.

TM1e
Stimulus: The student is presented with two equivalent rational expressions with missing components that may be found using structure without carrying out the calculation.

Example Stem 1: Drag one or more expressions into each box to create an equation that is true for all values of *x*. (Assume no denominator equals zero).

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

Preset Choices:

$x \quad x^2 \quad (x+2) \quad x(x+2) \quad (x^2+2)$

Example Stem 2: Drag one or more expressions into each box to create an equation that is true for all values of *x*. (Assume no denominator equals zero).

$$\frac{3}{x+2}+\frac{4}{x}+\frac{2}{x^2}=\frac{3\square+4\square+2\square}{\square}$$

Preset Choices:

$x \quad x^2 \quad (x + 2) \quad x(x + 2) \quad x^2(x + 2)$

Rubric: (1 point) The student drags the correct options.
Example Stem 1: x, $(x + 2)$, $x(x + 2)$;
Example Stem 2: x^2, $x(x + 2)$, $(x + 2)$, $x^2(x + 2)$

Response Type: Drag and Drop

Task Model 1

Response Type:
Drag and Drop

DOK Level 2

A-SSE.2
Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Evidence Required:
1. The student uses the structure of an expression to identify ways of rewriting it.

Tools: None

Prompt Features: The student is prompted to use the structure of an expression to create an expression that is equivalent to the given expression.

Stimulus Guidelines:

- Equivalences consist of equations of expressions.
- Expressions may be:
  - difference of two squares
  - sum/difference of two cubes
  - the product of two or three expressions
  - sum/difference of expressions that have a common factor
  - rational
  - exponential
- Difficulty level can be altered by varying the type of expression and/or the order of factors in a compound expression, and by using different variables and coefficients.

TM1f
Stimulus: The student is presented with two equivalent expressions with missing numbers that may be found using structure without carrying out the calculation.

Example Stem 1: Drag a number into each box to create an equation that is true for all values of *x*.

$$2(4x+3)(3x+5) = \square x^2 + 58x + \square$$

Palette Choices: 6 8 12 15 24 29 30 58

Example Stem 2: Drag a number into each box to create an equation that is true for all values of *x*.

$$\frac{3(n+2)(4n+1)}{6} = \square n^2 + \frac{9}{2}n + \square$$

Palette Choices: $\frac{1}{6}$ $\frac{1}{3}$ $\frac{1}{2}$ 1 2 4 6 12

Example Stem 3: Drag a number into the box to create an equation that is true for all values of *x*.

$$(x+2)^2 - 5 = x^2 + 4x + \square$$

Palette Choices: -4 -1 4 9

Task Model 1 **Response Type:** **Drag and Drop** **DOK Level 2** **A-SSE.2** Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$, *thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$. **Evidence Required:** 1. The student uses the structure of an expression to identify ways of rewriting it. **Tools:** None	**Example Stem 4:** Drag a number into the box to create an equation that is true for all values of x. $(x-7)^2 + 51 = x^2 + \boxed{}x + 100$ **Palette Choices:** -14, 0, 2, 14, 49 **Example Stem 5:** Drag a number into the box to create an equation that is true for all values of x. $\boxed{}(x-10)(x+12) = 3(x+1)^2 - 363$ **Palette Choices:** -12, -1, 1, 3, 10 **Rubric:** (1 point) The student places the correct number in the box(es). Example Stem 1: 24, 30; Example Stem 2: 2, 1; Example Stem 3: -1; Example Stem 4: -14; Example Stem 5: 3. **Response Type:** Drag and Drop

Task Model 1

Response Type:
Hot Spot

DOK Level 2

A-SSE.3a
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Factor a quadratic expression to reveal the zeros of the function it defines.

Evidence Required:
1. The student understands that the factored form of a quadratic expression reveals the zeros of the function it defines.

Tools: None

Prompt Features: The student identifies the factored form of an expression as best for revealing zeros and chooses the zeros.

Stimulus Guidelines:

- All numbers, variables, and operations should be changed to create an item.
- Difficulty level can be altered by varying the type of expression, and by using different variables and coefficients.

TM1a
Stimulus: The student is presented with equivalent quadratic equations for f(x).

Example Stem:
***Part A*:** Three equivalent equations for $f(x)$ are shown. Select the form that reveals the zeros of $f(x)$ without changing the form of the equation.

***Part B*:** Select all values of x for which $f(x) = 0$.

Part A:

$$f(x) = -2x^2 + 24x - 54$$

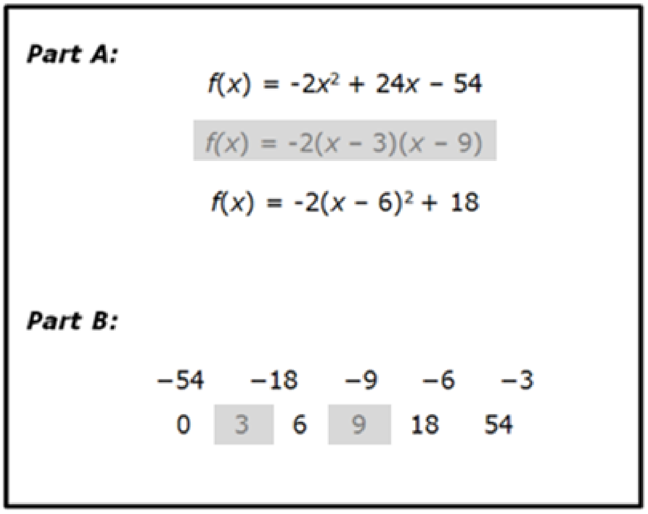
$$f(x) = -2(x - 3)(x - 9)$$

$$f(x) = -2(x - 6)^2 + 18$$

Part B:

−54 −18 −9 −6 −3
0 3 6 9 18 54

Rubric:
(1 point) The student selects the correct equation for $f(x)$ and selects the correct zeros.

	 **Part A:** $f(x) = -2x^2 + 24x - 54$ $f(x) = -2(x - 3)(x - 9)$ $f(x) = -2(x - 6)^2 + 18$ **Part B:** −54 −18 −9 −6 −3 0 3 6 9 18 54 **Response Type:** Hot spot

Task Model 1

Response Type:
Hot Spot

DOK Level 2

A-SSE.3a
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Factor a quadratic expression to reveal the zeros of the function it defines.

Evidence Required:
1. The student understands that the factored form of a quadratic expression reveals the zeros of the function it defines.

Tools: None

Prompt Features: The student identifies the standard form of a quadratic expression as best for finding the value of $f(x)$ when $x = 0$.

Stimulus Guidelines:

- All numbers, variables, and operations should be changed to create an item.
- Difficulty level can be altered by using different variables and coefficients.

TM1b
Stimulus: The student is presented with equivalent quadratic expressions for $f(x)$.

Example Stem:
Part A: Three equivalent equations for $f(x)$ are shown. Select the form that reveals the value of $f(x)$ when $x=0$ without changing the form of the equation.

Part B: Select the value of $f(x)$ when $x = 0$.

Part A:

$$f(x) = -2x^2 + 24x - 54$$

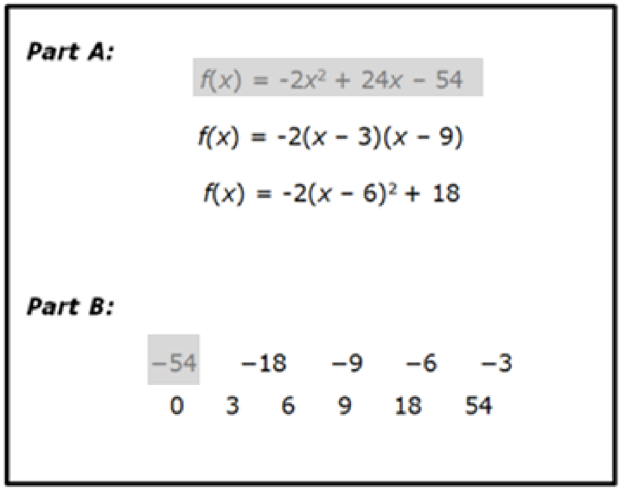
$$f(x) = -2(x - 3)(x - 9)$$

$$f(x) = -2(x - 6)^2 + 18$$

Part B:

−54 −18 −9 −6 −3
0 3 6 9 18 54

Rubric:
(1 point) The student selects the correct equation for $f(x)$ and selects the correct value for $f(x)$ when $x = 0$.

	 **Part A:** $f(x) = -2x^2 + 24x - 54$ $f(x) = -2(x - 3)(x - 9)$ $f(x) = -2(x - 6)^2 + 18$ **Part B:** −54 −18 −9 −6 −3 0 3 6 9 18 54 **Response Type:** Hot Spot

Task Model 2

Response Type:
Hot Spot

DOK Level 2

A-SSE.3b
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Evidence Required:
2. The student understands that completing the square for a quadratic expression reveals the maximum or minimum value of the function it defines.

Tools: None

Prompt Features: The student identifies the form of a given quadratic expression that reveals the maximum or minimum of the expression and chooses the maximum or minimum value of that expression.

Stimulus Guidelines:

- The completed square form is $a(x - h)^2 + k$, knowing that $h = -b/2a$ and $k = c - b^2/4a$
- Difficulty level can be altered by using different variables and coefficients.

TM2a
Stimulus: The student is presented with equivalent quadratic equations for $f(x)$.

Example Stem:
Part A: Three equivalent equations for $f(x)$ are shown. Select the form that reveals the maximum value of $f(x)$ without changing the form of the equation.

Part B: Select the maximum value of $f(x)$.

Part A:

$$f(x) = -2x^2 + 24x - 54$$

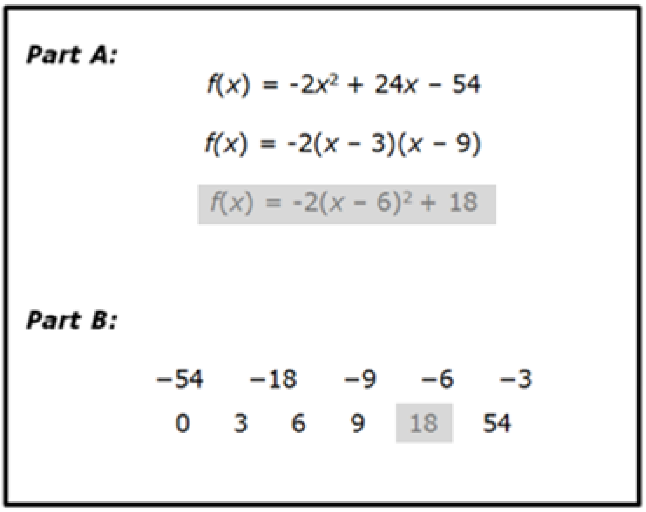
$$f(x) = -2(x - 3)(x - 9)$$

$$f(x) = -2(x - 6)^2 + 18$$

Part B:

−54 −18 −9 −6 −3
0 3 6 9 18 54

Rubric:
(1 point) The student selects the correct equation for $f(x)$ and selects the maximum value.

	 **Part A:** $f(x) = -2x^2 + 24x - 54$ $f(x) = -2(x - 3)(x - 9)$ $f(x) = -2(x - 6)^2 + 18$ **Part B:** −54 −18 −9 −6 −3 0 3 6 9 18 54 **Response Type:** Hot Spot

Task Model 2 **Response Type: Multiple Choice, single correct response** **DOK Level 1** **A-SSE.3b** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. **Evidence Required:** 2. The student understands that completing the square for a quadratic expression reveals the maximum or minimum value of the function it defines. **Tools:** None	**Prompt Features:** The student identifies the form of a given quadratic expression that reveals the maximum or minimum of the expression. **Stimulus Guidelines:** • The completed square form is $\mathrm{a}(x-\mathrm{h})^2+\mathrm{k}$, knowing that $\mathrm{h}=-\mathrm{b}/2\mathrm{a}$ and $\mathrm{k}=\mathrm{c}-\mathrm{b}^2/4\mathrm{a}$. • Difficulty level can be altered by using different variables and coefficients. **TM2b** **Stimulus:** The student is presented with four quadratic equations. **Example Stem:** Which equation reveals the minimum or maximum value of *f*(*x*) without changing the form of the equation? A. $f(x)=(x-1)^2-4$ B. $f(x)=x^2-2x-3$ C. $f(x)=x^2-3x+x-3$ D. $f(x)=(x+1)(x-3)$ **Rubric:** (1 point) The student correctly chooses the form that reveals the maximum or minimum of the quadratic function (e.g., A). **Response Type:** Multiple Choice, single correct response

Task Model 2

Response Type: Equation/Numeric

DOK Level 2

A-SSE.3b
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Evidence Required:
2. The student understands that completing the square for a quadratic expression reveals the maximum or minimum value of the function it defines.

Tools: None

Prompt Features: The student completes the square for a quadratic expression to reveal the maximum or minimum of the expression.

Stimulus Guidelines:

- The completed square form which is $\mathrm{a}(x-\mathrm{h})^2+\mathrm{k}$, knowing that $\mathrm{h}=-\mathrm{b}/2\mathrm{a}$ and $\mathrm{k}=\mathrm{c}-\mathrm{b}^2/4\mathrm{a}$
- Difficulty level can be altered by using different variables and coefficients.

TM2c
Stimulus: The student is presented with a quadratic function in standard form.

Example Stem 1: Enter the function $f(x)=x^2-7x-18$, in the form $f(x)=\mathrm{a}(x-\mathrm{h})^2+\mathrm{k}$, where a, h, and k are constants.

Enter your answer in the first response box.

Enter the *x*-coordinate of the minimum value of the function in the second response box.

Example Stem 2: Enter the function $f(x)=28x^2+16x-80$, in the form $f(x)=\mathrm{a}(x-\mathrm{h})^2+\mathrm{k}$, where a, h, and k are constants.

Enter your answer in the first response box.

Enter the *x*-coordinate of the minimum value of the function in the second response box.

Rubric:
(2 points) The student correctly enters the function in the equivalent form and enters the *x*-coordinate of the maximum value of the function [e.g., $f(x)=\left(x-\frac{7}{2}\right)^2-\frac{121}{4}$ and $\frac{7}{2}$; $28\left(x+\frac{2}{7}\right)^2-\frac{576}{7}$ and $-\frac{2}{7}$].
(1 point) The student correctly enters the function in the equivalent form **or** enters the *x*-coordinate of the maximum value of the function [e.g., $f(x)=\left(x-\frac{7}{2}\right)^2-\frac{121}{4}$ or $\frac{7}{2}$; $28\left(x+\frac{2}{7}\right)^2-\frac{576}{7}$ or $-\frac{2}{7}$].

Response Type: Equation/Numeric (two response boxes)

Task Model 3 **Response Type: Equation/Numeric;** **DOK Level 2** **A-SSE.3c** Use the properties of exponents to transform expressions for exponential functions. For example, the expression 1.15^t can be rewritten as $\approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%. **Evidence Required:** 3. The student uses the properties of exponents to transform exponential expressions. **Tools:** None	**Prompt Features:** The student uses the properties of exponents to produce an equivalent expression for an exponential expression (transforming expressions into both simpler and expanded forms, as specified in the stem). **Stimulus Guidelines:** • Exponential algebraic expressions with one or more variables, integer and rational coefficients, and rational exponents involving operations of addition, subtraction, multiplication, and division • Difficulty level can be altered by using different variables and exponents. **TM3a** **Stimulus:** The student is presented with an exponential expression and the form in which it is to be transformed. **Example Stem 1:** Enter an expression equivalent to $\left(\frac{a^9}{a^3}\right)$ in the form, a^m. **Example Stem 2:** Enter an expression equivalent to a^{20} in the form, $(a^n)^m$. **Example Stem 3:** Enter an expression equivalent to a^{-12} in the form $(a^n)^m$. **Example Stem 4:** Enter an expression equivalent to $(a^2a^4b)^5$ in the form, a^mb^n. **Rubric:** (1 point) The student correctly enters an equivalent expression in the given form [e.g., a^6; $(a^4)^5$; $(a^{-3})^4$; $a^{30}b^5$]. Multiple correct answers may be possible for some items. **Response Type:** Equation/Numeric

Task Model 3

Response Type: Multiple Choice, single correct response

DOK Level 2

A-SSE.3c
Use the properties of exponents to transform expressions for exponential functions. For example, the expression 1.15^t can be rewritten as $\approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Evidence Required:
3. The student uses the properties of exponents to transform exponential expressions.

Tools: Calculator

Prompt Features: The student is prompted to use the properties of exponents to transform exponential expressions.

Stimulus Guidelines:

- All numbers, variables, and operations should be changed to create an item.
- Difficulty level can be altered by using different variables and coefficients.

TM3b
Stimulus: The student is presented with a contextual situation and an exponential expression representing an exponentially increasing or decreasing quantity within the given situation.

Example Stem: This expression defines a function that models the future population of wolves in a park after *t* years.

$3280(1.15)^t$

Which expression best defines the function that represents the wolf population after *x* months?

A. $3280(1.0125)^x$
B. $3280(1.0117)^x$
C. $3280(1.12)^x$
D. $3280(1.2)^x$

Rubric: (1 point) Student selects the correct expression (e.g., B).

Response Type: Multiple Choice, single correct response

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 2** **A-SSE.3c** Use the properties of exponents to transform expressions for exponential functions. For example, the expression 1.15^t can be rewritten as $\approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%. **Evidence Required:** 3. The student uses the properties of exponents to transform exponential expressions. **Tools:** Calculator	**Prompt Features:** The student is prompted to use the properties of exponents to transform exponential expressions to find the growth or decay rate for different units of time. **Stimulus Guidelines:** • All numbers, variables, and operations should be changed to create an item. • Difficulty level can be altered by using different variables and coefficients. **TM3c** **Stimulus**: The student is presented with a contextual situation and an exponential expression representing an exponentially increasing or decreasing quantity within the given situation. **Example Stem:** This expression defines a function that models the future population of wolves in a park after *x* months. $3280(1.0117)^x$ Enter the yearly growth rate for the wolf population as a percent. Round to the nearest hundredth. **Rubric:** (1 point) Student produces the correct growth or decay rate (e.g., 14.98%). **Response Type:** Equation/Numeric

Task Model 1 **Response Type: Equation/Numeric** **DOK Level 2** **A-APR.1** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. **Evidence Required:** 1. The student adds or subtracts polynomials. **Tools:** None	**Prompt Features:** The student is prompted to enter an equivalent expression. The equation is created from determining the sum or difference of the polynomials in the given expression. **Stimulus Guidelines:** Item difficulty can be adjusted via these example methods, but are not limited to these methods: • Two or more multivariate monomials where at least two have the same variables and powers (e.g, $3x^2y + 7x^2y$), • Two or more single variable polynomials (including monomials) where all the terms are degree 2 or less (e.g $(6x^2 + 7x) + (4x^2 - 3x)$), • Two or more multivariate polynomials (including monomials) where at least two have terms with the same variables and powers and all the terms are degree 2 or less, or • Two or more multivariate polynomials (including monomials) of any degree where at least two have terms with the same variables and powers. **TM1** **Stimulus:** The student is presented with an expression involving the addition and/or subtraction of polynomials. **Example Stem 1:** Enter an expression equivalent to $(4x^2 - 5x + 6) + (9x^2 - 2x) - (11x - 3)$ using the fewest number of possible terms. **Example Stem 2:** Enter an expression equivalent to $(4x^2 - 5yz + 6) - (9x^2 - 2z) + (11yz - 3)$ using the fewest number of possible terms. **Rubric:** (1 point) The student enters a correct expression (e.g., $13x^2 - 18x + 9$, $-5x^2 + 6yz + 2z + 3$). **Response Type:** Equation/Numeric

Task Model 2 **Response Type:** **Equation/Numeric** **DOK Level 2** **A-APR.1** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. **Evidence Required:** 2. The student multiplies polynomials. **Tools:** None	**Prompt Features:** The student is prompted to enter an equivalent expression. The equation is created from determining the product or quotient of the polynomials in the given expression. **Stimulus Guidelines:** Item difficulty can be adjusted via these example methods, but are not limited to these methods: • Two or more multivariate monomials, • Two or more single variable polynomials (including monomials) where all the terms are degree 2 or less, • Two or more multivariate polynomials (including monomials) where all the terms are degree 2 or less, or • Two or more multivariate polynomials (including monomials) of any degree. **TM2** **Stimulus:** The student is presented with an expression involving the product of polynomials. **Example Stem 1:** Enter an expression equivalent to $9x^2y(-8x^2y)$ in the form A$x^m y^n$. **Example Stem 2:** Multiply and combine like terms to determine the product of these polynomials. $(2x-3)(5x+6)$ Enter your result in the response box. **Example Stem 3:** Multiply and combine like terms to determine the product of these polynomials. $(4x^2-5xy+6)y(5x+6)$ Enter your result in the response box. **Example Stem 4:** Multiply and combine like terms to determine the product of these polynomials. $(4x+1)(x+6)(x-2)$ Enter your result in the response box. **Rubric:** (1 point) The student correctly multiplies and combines like terms (e.g., $-72x^4y^2$; $10x^2-3x-18$; $20x^3y+24x^2y-25x^2y^2-30xy^2+30xy+36y$; $4x^3+17x^2-44x-12$). **Response Type:** Equation/Numeric

Task Model 1

Response Type: Equation/Numeric

DOK Level 2

A-CED.1
Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions and simple rational and exponential functions.*

Evidence Required:
1. The student creates one variable equations arising from linear, quadratic, simple rational, and exponential functions in one variable.

Tools: Calculator

Prompt Features: The student is prompted to create a one variable equation that can be used to solve a given problem.

Stimulus Guidelines:

- The student is presented with a contextual situation familiar to 16 to 17 year olds that:
    - can be modeled by a function equal to a given value
    - The unknown value of a quantity is represented as a multivariable equation with various parameters given in context.
    - The equations reduce to one variable linear, quadratic, simple rational, or exponential equations.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - The form of the equation being created:
        - is linear
        - is quadratic
        - is simple rational
        - is exponential
    - The complexity of the contextual situation:
        - The unknown variable is referenced directly in the contextual situation.
        - The quantity in relation is the unknown variable.
        - The quantity in relation is not the unknown variable, but rather an expression involving that variable.

TM1
Stimulus: The student is presented with a contextual problem.

Example Stem 1: Consider the equation that models a train's distance from its departing station, where:

- y represents the distance in miles
- x represents the speed of the train in miles per hour, and
- t represents the time traveled from the departing station in hours.

$$y = xt$$

Enter an equation for which the solution is the speed of the train, in miles per hour, where the train's distance from the departing station is 162 miles and it has traveled for 3 hours.

Rubric: (1 point) The student correctly enters an equation (e.g., equation equivalent to $x = 54$).

Response Type: Equation/Numeric

Task Model 1

Response Type: Equation/Numeric

DOK Level 2

A-CED.1
Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions and simple rational and exponential functions.*

Evidence Required:
1. The student creates one variable equations arising from linear, quadratic, simple rational, and exponential functions in one variable.

Tools: Calculator

Example Stem 2: Consider the equation that gives the minimum stopping distance, *d,* in feet, for an automobile, where:

- v represents the automobile speed, in feet per second,
- s represents the driver's response time, in seconds, before applying the brakes, and
- m represents the coefficient of friction between the tires and the road.

$$d = vs + \frac{v^2}{64m}$$

Enter an equation for which the solution is the speed, in feet per second, of an automobile with a stopping distance of 200 feet, a driver's response time of 0.5 second, and a coefficient of friction equal to 0.8.

Rubric: (1 point) The student correctly enters an equation (e.g., equation equivalent $\frac{v^2}{51.2} + \frac{v}{2} = 200$).

Example Stem 3: A sales clerk's daily earnings include $125 per day plus commission equal to x% of his daily sales.

Enter an equation that can be used to find the commission percentage (x), if the clerk's daily sales are $1375 and his total earnings for that day are $180.

Rubric: (1 point) The student correctly enters an equation [e.g., $x = \frac{(180-125)}{1375}(100)$].

Example Stem 4: Jim can paint a house in 12 hours. Alex can paint the same house in 8 hours.

Enter an equation that can be used to find the time in hours, t, it would take Alex and Jim to paint the house together.

Rubric: (1 point) The student correctly enters an equation (e.g., $\frac{1}{12} + \frac{1}{8} = \frac{1}{t}$).

Response Type: Equation/Numeric

Task Model 2

Response Type: Equation/Numeric

DOK Level 2

A-CED.1
Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions and simple rational and exponential functions.*

Evidence Required:
2. The student creates one variable inequalities arising from linear, quadratic, simple rational, and exponential functions in one variable.

Tools: Calculator

Prompt Features: The student is prompted to create a one variable inequality and then use the inequality that can be used to solve a given problem.

Stimulus Guidelines:

- The student is presented with a contextual situation familiar to 16 to 17 year olds that:
    - can be modeled by a function greater than, less than, greater than or equal to, or less than or equal to a given value
    - The unknown value of a quantity is represented as a multivariable equation with various parameters given in context.
    - The inequalities reduce to one variable linear, quadratic, or simple rational equation.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - The form of the inequality being created:
        - is linear
        - is quadratic
        - is simple rational
    - The complexity of the contextual situation:
        - The unknown variable is referenced directly in the contextual situation.
        - The quantity in relation is the unknown variable.
        - The quantity in relation is not the unknown variable, but rather an expression involving that variable.

TM2
Stimulus: The student is presented with a contextual situation.

Example Stem 1: A clerk earns $125 per day, plus a commission equal to 10% of her sales, *s*. The clerk earns less than $180 on Monday.

Enter an inequality that represents all possible values for the clerk's sales, *s*, on Monday.

Rubric: (1 point) The student correctly enters the inequality [e.g., inequality equivalent to $s < 10(180 - 125)$].

Example Stem 2: A rectangular garden measuring 13 meters by 15 meters is to have a gravel pathway of constant width built all around it. There is enough gravel to cover 80 square meters.

Enter an inequality that represents all possible widths (w), in meters, of the pathway.

Rubric:
(1 point) The student correctly enters an inequality equivalent to $(13 + 2w)(15 + 2w) - 13(15) \leq 80$.

Response Type: Equation/Numeric

Task Model 3

Response Type: Graphing

DOK Level 2

A-CED.2
Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Evidence Required:

3. The student graphs equations on the coordinate axes with labels and scales to represent the solution to a contextual problem..

Tools: Calculator

Prompt Features: The student is prompted to create a graph from a contextual situation.

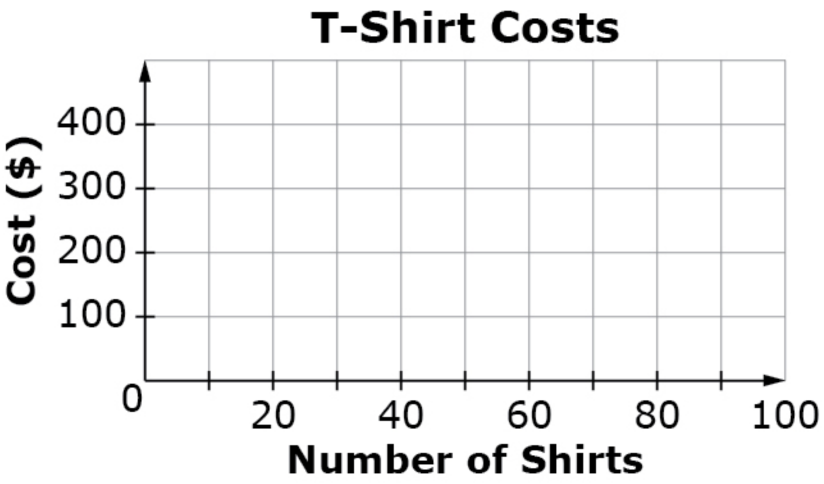
Stimulus Guidelines:

- The student is presented with a contextual situation familiar to 16 to 17 year olds that:
    - can be modeled as a function equal to a given value
    - The unknown value of a quantity is represented as a multivariable equation with various parameters given in context.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - The form of the equation being created:
        - is linear
        - is quadratic
        - is simple rational
        - is exponential
    - The complexity of the contextual situation:
        - The unknown variable is referenced directly in the contextual situation.
        - The quantity in relation is the unknown variable.
        - The quantity in relation is not the unknown variable, but rather an expression involving that variable.

TM3
Stimulus: The student is presented with a contextual situation and a labeled coordinate grid.

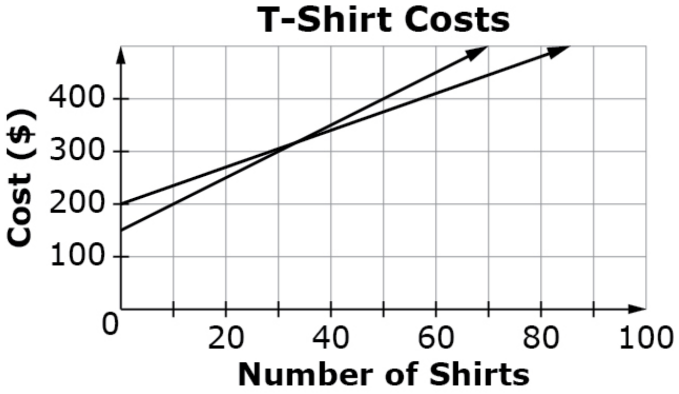
Example Stem: A school is having T-shirts printed. Scott's T-shirts charges $150 to set up the printing, and then $5 per T-shirt. Barbara's T-shirts charges $200 to set up the printing and then $3.50 per T-shirt.

Use the Add Arrow tool to represent functions that show the cost of buying *n* T-shirts from each store.



Interaction: The student uses the Add arrow tool to graph the functions represented in the context.

Rubric:
(1 point) The student correctly graphs the functions.



Response Type: Graphing

Task Model 4

Response Type: Equation/Numeric

DOK Level 1

A-CED.1
Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions and simple rational and exponential functions.

Evidence Required:
4. The student creates equations in two or more variables to represent relationships between quantities.

Tools: Calculator

Prompt Features: The student is prompted to create an equation in two or more variables that can be used to solve a given problem.

Stimulus Guidelines:

- The student is presented with a contextual situation familiar to 16 to 17 year olds that:
  - can be modeled by an equation
  - The unknown value of a quantity is represented as a multivariable equation with various parameters given in context.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - The form of the equation being created:
    - is linear
    - is quadratic
    - is simple rational
    - is exponential
  - The complexity of the contextual situation:
    - The unknown variable is referenced directly in the contextual situation.
    - The quantity in relation is the unknown variable.
    - The quantity in relation is not the unknown variable, but rather an expression involving that variable.
  - The number of variables in the equation.

TM4
Stimulus: The student is presented with a contextual situation.

Example Stem 1: Malik and Nora are playing a video game.

- Malik starts with m points and Nora starts n points.
- Then Malik gets 150 more points, while Nora loses 50 points.
- Finally, Nora gets a bonus and her score is doubled.
- Nora now has 50 more points than Malik.

Enter an equation expressing the fact that Nora now has 50 more points than Malik.

Rubric: (1 point) The student correctly enters the equation [e.g., equation equivalent to $2(n-50)=(m+150)+50$].

Example Stem 2: A customer pays c dollars to rent a car for one day plus m dollars per mile. The cost of gasoline is included in the value of c.

Enter an equation for the total cost, t, to rent the car for one day and drive d miles.

Rubric: (1 point) The student correctly enters the equation (e.g., equation equivalent to $t=c+md$).

Response Type: Equation/Numeric

Task Model 1

Response Type:

Equation/numeric

DOK Levels 1, 2

A-REI.2
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Evidence Required:
1. The student solves radical and/or simple rational equations in one variable, including identifying the number and type of real solutions that might exist for the equation (e.g., one, two, infinite, or no real).

Tools: None

Prompt Features: Enter the solution to a rational or radical equation.

Stimulus Guidelines:

- Equations cannot have no solutions.
- Solutions must be rational numbers.
- Equations should not have extraneous roots.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - variable is present on only one side of the equation
    - multiple rational quantities on both sides of the equation
    - Multiple rational quantities with differing denominators
    - radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable
    - radicals of the form $\sqrt{ax+b}$ where *a* and *b* are constants and *x* is a variable

TM1a
Stimulus: The stem will present a rational equation in one variable with exactly one real solution (limit responses to those that can be expressed by rational numbers).

Example Stem 1 (DOK 1): Enter the value of *x* that makes the equation true.

$$\frac{1}{x}=5$$

Rubric: (1 point) The student enters the correct value of *x* (e.g., $\frac{1}{5}$).

Example Stem 2 (DOK 2): Enter the value of *x* that makes the equation true.

$$\frac{1}{x-4}=\frac{3}{x}$$

Rubric: (1 point) The student enters the correct value of *x* (e.g., 6).

Response Type: Equation/numeric

Task Model 1 **Response Type:** **Equation/numeric** **DOK Levels 1, 2** **A-REI.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **Evidence Required:** 1. The student solves radical and/or simple rational equations in one variable, including identifying the number and type of real solutions that might exist for the equation (e.g., one, two, infinite, or no real). **Tools:** None	**TM1b** **Stimulus:** The stem will present a radical equation with one or two real solutions. **Example Stem 1 (DOK 1):** Enter the value of *x* that makes the equation true. $\sqrt{x} = 8$ **Rubric:** (1 point) The student enters the correct solution(s) (e.g., 64). **Example Stem 2 (DOK 2):** Enter the value(s) of *x* that make the equation true. $x - 1 = \sqrt{5x - 9}$ Enter one solution in the first response box. If there are two solutions, enter the second solution in the second response box. **Rubric:** (1 point) The student enters the correct solution(s) (e.g., 2, 5). **Response Type:** Equation/numeric

Task Model 1

Response Type:
Matching Tables

DOK Level 2

A-REI.2
Solve simple rational and radical equations in one variable and give examples showing how extraneous solutions may arise.

Evidence Required:
1. The student solves radical and/or simple rational equations in one variable, including identifying the number and type of real solutions that might exist for the equation (e.g., one, two, infinite, or no real).

Tools: None

Prompt Features: Give the number of real solutions to a rational or radical equation.

Stimulus Guidelines:

- Solutions, if any, must be rational numbers.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - variable is present on only one side of the equation
    - multiple rational quantities on both sides of the equation
    - Multiple rational quantities with differing denominators
    - radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable
    - radicals of the form $\sqrt{ax+b}$ where *a* and *b* are constants and *x* is a variable

TM1c
Stimulus: A table with three equations in one variable, where at least two are rational or radical.

Example Stem 1: Select whether each equation has no real solution, one real solution, or infinitely many real solutions.

	No Real Solution	**One Real Solution**	**Infinitely Many Real Solutions**
$\sqrt{x}+2=0$			
$\frac{10}{x}=\frac{20}{x+20}$			
$\frac{3}{x}=\frac{2}{x+1}$			

Rubric: (1 point) The student chooses the correct classification for each equation (e.g., No Real Solution, One Real Solution, One Real Solution).

Response Type: Matching Tables

Task Model 1

Response Type:
Matching Tables

DOK Level 2

A-REI.2
Solve simple rational and radical equations in one variable and give examples showing how extraneous solutions may arise.

Evidence Required:
1. The student solves radical and/or simple rational equations in one variable, including identifying the number and type of real solutions that might exist for the equation (e.g., one, two, infinite, or no real).

Tools: None

Example Stem 2: Select whether each equation has no real solution, one real solution, or infinitely many real solutions.

	No Real Solution	One Real Solution	Two Real Solutions
$\sqrt{x} + 2 = 0$			
$\sqrt{x^2 - 5} = 2$			
$\frac{3}{x} = \frac{2}{x+1}$			

Rubric: (1 point) The student chooses the correct classification for each equation (e.g., No Real Solution, Two Real Solutions, One Real Solution).

Example Stem 3: Select whether each equation has no real solution, one real solution, or infinitely many real solutions.

	No Real Solution	One Real Solution	Two Real Solutions	Infinitely Many Real Solutions
$\sqrt{x} + 2 = 0$				
$\frac{4x}{12} = \frac{3x}{9}$				
$\frac{3}{x} = \frac{2}{x+1}$				
$\sqrt{x^2 - 5} = 2$				

Rubric: (1 point) The student chooses the correct classification for each equation (e.g., No Real Solution, Infinitely Many Real Solutions, One Real Solution, Two Real Solutions).

Response Type: Matching Tables

Task Model 1

Response Type:
Matching Tables

DOK Level 1

A-REI.2
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Evidence Required:
1. The student solves radical and/or simple rational equations in one variable, including identifying the number and type of real solutions that might exist for the equation (e.g., one, two, infinite, or no real).

Tools: None

Prompt Features: Select solutions to a given rational or radical equation.

Stimulus Guidelines:

- Solutions must be rational numbers.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - variable is present on only one side of the equation
  - multiple rational quantities on both sides of the equation
  - Multiple rational quantities with differing denominators
  - radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable
  - radicals of the form $\sqrt{ax+b}$ where *a* and *b* are constants and *x* is a variable

TM1d
Stimulus: The stem will present an equation with one or two real solutions.

Example Stem: Select Yes or No to indicate whether each value of *x* is a solution to the given equation.

$$\frac{3}{4}=\frac{2}{x+1}$$

Solution	Yes	No
$x = 3$		
$x = \frac{5}{3}$		
$X = \frac{3}{5}$		

Rubric: (1 point) The student correctly determines whether each value of *x* is a solution to the equation (e.g., NYN).

Response Type: Matching Tables

Task Model 2

Response Type:

Multiple Choice, single correct response

DOK Level 2

A-REI.2

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Evidence Required:
2. The student evaluates proposed solutions to radical or simple rational equations, and recognizes where extraneous solution(s) might arise during the solving of the equation.

Tools: None

Prompt Features: Identify the statement that correctly applies to the given solution of an equation.

Stimulus Guidelines:

- The student is presented with a student's step by step solution to a problem involving rational and/or radical equations.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - variable is present on only one side of the equation
  - multiple rational quantities on both sides of the equation
  - Multiple rational quantities with differing denominators
  - radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable
  - radicals of the form $\sqrt{ax+b}$ where *a* and *b* are constants and *x* is a variable

TM2
Stimulus: The student is presented with multiple statements about the solution of a rational and/or radical equation.

Example Stem 1: A student solved $1+\sqrt{x-3}=0$ in four steps, as shown.

Step 1: $\sqrt{x-3} = -1$
Step 2: $\left(\sqrt{x-3}\right)^2 = (-1)^2$
Step 3: $x - 3 = 1$
Step 4: $x = 4$

Which statement is an accurate interpretation of the student's work?

A. The correct solution is $x = 4$.
B. The student made an error in Step 1.
C. The student made an error in Step 3.
D. x=2 is a solution to the equation in Step 2, but not to the original equation.

Rubric: (1 point) The student selects the correct statement (e.g., D).

Response Type: Multiple Choice, single correct response

Task Model 2

Response Type:

Multiple Choice, single correct response

DOK Level 2

A-REI.2

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Evidence Required:
2. The student evaluates proposed solutions to radical or simple rational equations, and recognizes where extraneous solution(s) might arise during the solving of the equation.

Tools: None

Example Stem 2: A student solved $\sqrt{x^2-5}-2=0$ in five steps, as shown.

Step 1: $\sqrt{x^2-5}=2$

Step 2: $\left(\sqrt{x^2-5}\right)^2=2^2$

Step 3: $x^2-5 = 4$

Step 4: $x^2=9$

Step 5: $x=3,\ x=-3$

Which statement is an accurate interpretation of the student's work?

A. The student solved the equation correctly.
B. The student made an error in Step 2.
C. Only $x = -3$ is a solution to the original equation.
D. Only $x = 3$ is a solution to the original equation.

Rubric: (1 point) The student selects the correct statement (e.g., A).

Response Type: Multiple Choice, single correct response

Task Model 1 **Response Type: Equation/Numeric** **DOK Level 1** **A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **Evidence Required:** 1. The student understands that the factored form of a quadratic expression reveals the zeroes of the function it defines. **Tools:** None	**Prompt Features:** The student is prompted to solve a one-step linear equation. **Stimulus Guidelines:** • *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3). • One-variable, linear equation with numeric coefficients. • Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses. **TM1a** **Stimulus:** The student is presented with a one-variable, linear equation that can be solved in one step. **Example Stem:** Enter the value for *x* that makes the given equation true. $48 = x - 3$ **Rubric:** (1 point) The student enters the correct value for the variable *x* (e.g., 51). **Response Type:** Equation/Numeric

Task Model 1

Response Type: Equation/Numeric

DOK Level 2

A-REI.3
Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Evidence Required:
1. The student understands that the factored form of a quadratic expression reveals the zeroes of the function it defines.

Tools: None

Prompt Features: The student is prompted to solve a multi-step linear equation.

Stimulus Guidelines:

- *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3).
- One-variable, linear equation with numeric coefficients.
- Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses.

TM1b
Stimulus: The student is presented with a one-variable, linear equation that can be solved in multiple steps.

Example Stem: Enter the value for *x* that makes the given equation true.

$20x - 5(6x + 4) = 4x - 6$

Rubric:
(1 point) The student enters the correct value for the variable *x* (e.g., -1).

Response Type: Equation/Numeric

Task Model 2a-b **Response Types: Equation/Numeric; Multiple Choice, single correct response** **DOK Level 1** **A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **Evidence Required:** 2. The student solves linear inequalities in one variable with numeric coefficients. **Tools:** None	**Prompt Features:** The student is prompted to solve a one-step linear inequality. **Stimulus Guidelines:** • Item difficulty can be varied by adjusting the number of steps involved in solving inequalities, as well as the use of parentheses. • *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3). **TM2a** **Stimulus:** The student is presented with a one-variable linear inequality that can be solved in one step. **Example Stem:** Solve the inequality for *n*. $45 \geq -15n$. **Rubric:** (1 point) The student enters the correct solution to the inequality (e.g., $n \geq -3$). **Response Type:** Equation/Numeric **TM2b** **Stimulus:** The student is presented with a one-variable, one-step linear inequality. **Example Stem:** Which inequality represents all possible solutions of $-3n < 12$? A. $n < -36$ B. $n < -4$ C. $n > -36$ D. $n > -4$ **Rubric:** (1 point) The student selects the correct option (e.g., D). **Response Type:** Multiple Choice, single correct response

Task Model 2c

Response Types: Equation/Numeric; Matching Tables

DOK Level 2

A-REI.3
Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Evidence Required:
2. The student solves linear inequalities in one variable with numeric coefficients.

Tools: None

Prompt Features: The student is prompted to solve a multi-step linear inequality.

Stimulus Guidelines:

- Item difficulty can be varied by adjusting the number of steps involved in solving inequalities, as well as the use of parentheses.
- *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3).

Stimulus: The student is presented with a one-variable, multi-step linear inequality.

TM2c
Example Stem: Solve the inequality for *w*.

$-2w + 17 < 13.$

Rubric:
(1 point) The student enters the correct solution to the inequality (e.g., $w > 2$).

Response Type: Equation/Numeric

TM2d
Example Stem: Evaluate the claim as True or False for each set of numbers.

Claim: All members of the set are solutions for *w* in the given inequality.

$20w - 5(6w + 4) \geq 4w - 6$

Decide if all members of each set are solutions. Click True or False.

	True	False
{all negative real numbers}		
{-1, 0, 1, 2}		
{all positive real numbers}		
{-3, -2, -1}		
{-1}		

Rubric:
(1 point) The student correctly matches true or false to each option (e.g., FFFTT).

Response Type: Matching Tables

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 1** **A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **Evidence Required:** 3. The student solves linear inequalities in one variable with letter coefficients or identifies appropriate value(s) of a letter coefficient given specific information about a variable in a linear equation or inequality. **Tools:** None	**Prompt Features:** The student is asked to solve a one-step linear equation to identify appropriate value(s) of a letter coefficient given specific information about a variable. **Stimulus Guidelines**: • *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3). • One-variable linear equation with some coefficients represented as letters. • Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses. **TM3a** **Stimulus:** The student is presented with a linear equation solvable in one step. **Example Stem 1:** For the given equation, enter the value of B when x = 10. $Bx = 20$ **Example Stem 2:** For the given equation, enter the value of B when $x = \frac{1}{4}$. $Bx = 20$ **Example Stem 3:** For the given equation, enter the value of B when x = -5. $\frac{B}{x} = 20$ **Rubric:** (1 point) The student enters the correct value for B (e.g., 2; 80; -100). **Response Type:** Equation/Numeric

Task Model 3

Response Type:
Equation/Numeric

DOK Level 1

A-REI.3
Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Evidence Required:
3. The student solves linear inequalities in one variable with letter coefficients or identifies appropriate value(s) of a letter coefficient given specific information about a variable in a linear equation or inequality.

Tools: None

Prompt Features: The student is asked to solve a one-step linear equation in one variable with letter coefficients.

Stimulus Guidelines:
- *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3).
- One-variable linear equation with some coefficients represented as letters.
- Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses.

TM3b
Stimulus: The student is presented with a linear equation requiring one step to solve.

Example Stem: Solve the given equation for *x*.

$$\frac{x}{\mathrm{B}} = 20$$

Rubric:
(1 point) The student enters the correct equation (e.g., $x = 20\mathrm{B}$).

Response Type: Equation/Numeric

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 2** **A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **Evidence Required:** 3. The student solves linear inequalities in one variable with letter coefficients or identifies appropriate value(s) of a letter coefficient given specific information about a variable in a linear equation or inequality. **Tools:** None	**Prompt Features:** The student is asked to solve a multi-step linear equation in one variable with letter coefficients. **Stimulus Guidelines**: • *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3). • One-variable linear equation with some coefficients represented as letters. • Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses. **TM3c** **Stimulus:** The student is presented with a linear equation requiring at least two steps to solve. **Example Stem:** Solve the given equation for *x*. $6x + \mathrm{C}x = 11$ **Rubric:** (1 point) The student enters the correct equation (e.g., $x = \frac{11}{6+\mathrm{C}}$). **Response Type:** Equation/Numeric

Task Model 3

Response Type: Equation/Numeric

DOK Level 2

A-REI.3
Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Evidence Required:
3. The student solves linear inequalities in one variable with letter coefficients or identifies appropriate value(s) of a letter coefficient given specific information about a variable in a linear equation or inequality.

Tools: None

Prompt Features: The student is asked to solve a multi-step linear equation to identify appropriate value(s) of a letter coefficient given specific information about a variable.

Stimulus Guidelines:

- *x* may be fractional or decimal. If decimal, the precision of *x* values can only be taken out to the tenths place (e.g., 1.3).
- One-variable linear equation with some coefficients represented as letters.
- Item difficulty can be varied by adjusting the number of steps involved in solving equations, as well as the use of parentheses.

TM3d
Stimulus: The student is presented with a linear equation requiring a minimum of two steps to solve.

Example Stem 1: For the given equation, enter the value of B when $x = \frac{1}{5}$.

$$\frac{x}{\mathrm{B}} = 20$$

Example Stem 2: For the given equation, enter the value of C when F = 77.

$$\mathrm{F} = \frac{9}{5}\mathrm{C} + 32$$

Rubric:
(1 point) The student enters the correct solution (e.g., 1/100 or 0.01; 25).

Response Type: Equation/Numeric

Task Model 4

Response Type: Equation/Numeric

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

Evidence Required:
4. The student solves quadratic equations in one variable by taking square roots, completing the square, using the quadratic formula, or by factoring.

6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers.

Tools: None

Prompt Features: The student is prompted to solve a quadratic equation of the form $ax^2 = b$ by taking the square root, resulting in two real solutions.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The quadratic equation used can:
    - have rational roots
    - irrational roots
    - complex roots
  - The form of the quadratic equation can be
    - standard form, $ax^2 + bx + c = 0$.
    - vertex form, $f(x) = a(x-h)^2 + k$,
    - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4a
Stimulus: The student is presented with a quadratic equation in one variable equivalent to $ax^2 = b$ (with *a* and *b* as nonzero integers).

Example Stem: Solve the following equation for *n*.

$$18n^2 - 50 = 0$$

Enter one solution in the first box. If there are two solutions, enter the second solution in the second box.

Rubric:
(1 point) The student correctly enters the solution(s) to the equation (e.g., $x = -\frac{5}{3}$ and $x = +\frac{5}{3}$).

Response Type: Equation/Numeric (two response boxes)

Task Model 4

Response Type: Equation/Numeric

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

Evidence Required:
4. The student solves quadratic equations in one variable by taking square roots, completing the square, using the quadratic formula, or by factoring.

6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers.

Tools: None

Prompt Features: The student is prompted to solve a quadratic equation of the form $ax^2 = b$ by taking the square root, resulting in two unique complex solutions.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - The quadratic equation used can:
        - have rational roots
        - irrational roots
        - complex roots
    - The form of the quadratic equation can be
        - standard form, $ax^2 + bx + c = 0$.
        - vertex form, $f(x) = a(x-h)^2 + k$,
        - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4b
Stimulus: The student is presented with a quadratic equation in one variable equivalent to $ax^2 = b$ (with *a* and *b* as nonzero integers).

Example Stem: Solve the following equation for *n*.

$$18n^2 + 50 = 0$$

Enter one solution in the first box. If there are two solutions, enter the second solution in the second box.

Rubric:
(1 point) The student correctly enters the solution(s) to the equation (e.g., $x = -\frac{5}{3}i$ and $x = +\frac{5}{3}i$).

Response Type: Equation/Numeric (two response boxes)

Task Model 4

Response Type: Drag and Drop, Graphing

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

a) Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x-p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b) Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers *a* and *b*.

Evidence Required:
4. The student solves quadratic equations

Prompt Features: The student is prompted to solve a quadratic equation of the form $ax^2 + bx + c = 0$ by completing the square.

Stimulus Guidelines:

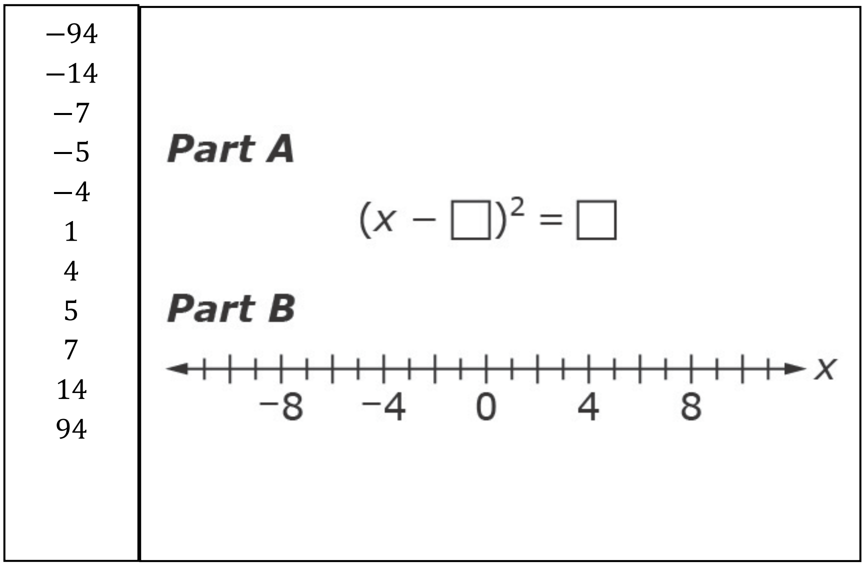
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The quadratic equation used can:
    - have rational roots
    - irrational roots
    - complex roots
  - The form of the quadratic equation can be
    - standard form, $ax^2 + bx + c = 0$.
    - vertex form, $f(x) = a(x-h)^2 + k$,
    - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4c
Stimulus: The student is presented with a quadratic equation in one variable equivalent to $ax^2 + bx + c = 0$ (with *a* and *b* as nonzero integers).

Example Stem: Consider the equation: $x^2 - 14x + 45 = 0$

Part A: Drag numbers into the boxes to rewrite the equation in the form shown.

Part B: Use the Add Point tool to place a point for each solution on the number line.

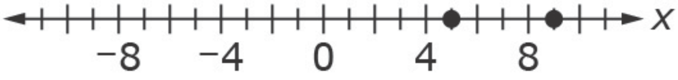


-94
-14
-7
-5
-4
1
4
5
7
14
94

Part A

$(x - \square)^2 = \square$

Part B

in one variable by taking square roots, completing the square, using the quadratic formula, or by factoring. 6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers. **Tools:** None	**Interaction:** For the first part, the student will use drag and drop to rewrite the equation. For the second part, the student plots points on a number line. **Rubric:** (2 points) The student correctly rewrites the equation [1 point] and correctly places both points on the number line [1 point] (e.g., 7; 4; points at 5 and 9). ***Part A*** $(x - \boxed{7})^2 = \boxed{4}$ ***Part B***  **Response Type:** Drag and Drop, Graphing

Task Model 4

Response Type:
Drag and Drop, Graphing

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

a) Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x–p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b) Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers *a* and *b*.

Evidence Required:
4. The student solves quadratic equations

Prompt Features: The student is prompted to setup and solve a quadratic equation using the quadratic formula.

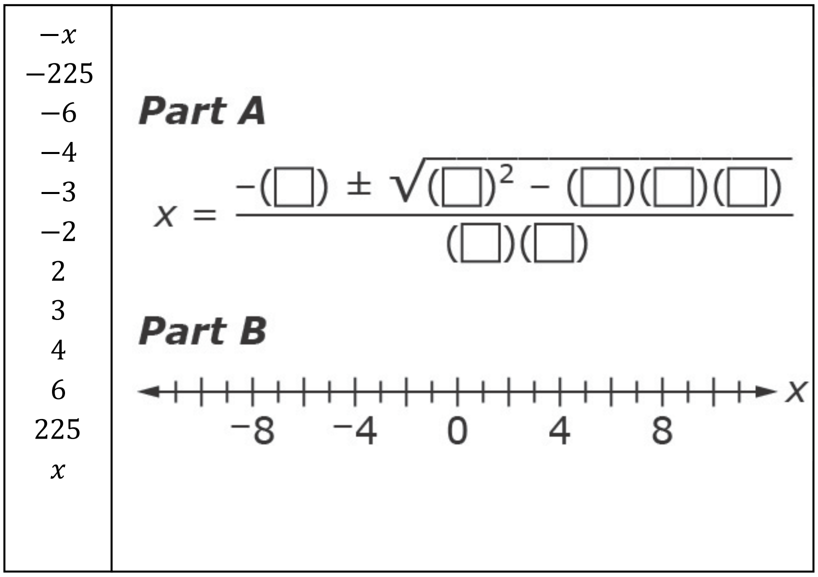
Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The quadratic equation used can:
    - have rational roots
    - irrational roots
    - complex roots
  - The form of the quadratic equation can be
    - standard form, $ax^2 + bx + c = 0$.
    - vertex form, $f(x) = a(x - h)^2 + k$,
    - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x - 3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4d
Stimulus: The student is given a quadratic equation in standard form: $ax^2 + bx + c = 0$ where a, b, and c are all one-digit numbers

Example Stem:
Part A: Drag and drop numbers from the list to enter an equivalent equation for $3x^2 + 2x - 225 = 0$ into the quadratic formula.

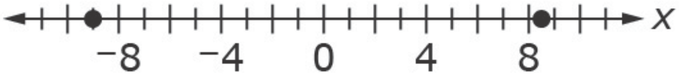
Part B: Use the Add Point tool to place a point for each solution on the number line


$-x$
-225
-6
-4
-3
-2
2
3
4
6
225
x

Part A

$$x = \frac{-(\square) \pm \sqrt{(\square)^2 - (\square)(\square)(\square)}}{(\square)(\square)}$$

Part B

in one variable by taking square roots, completing the square, using the quadratic formula, or by factoring. 6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers. **Tools:** None	**Interaction:** For the first part, the student will use drag and drop to enter a quadratic formula. **Rubric:** (2 points) The student produces the correct quadratic formula and two correct values for *n*. (1 point) The student produces the correct quadratic formula **or** two correct values for *n.* ***Part A*** $x = \frac{-(2) \pm \sqrt{(2)^2 - (4)(3)(-225)}}{(2)(3)}$ ***Part B***  **Response Type:** Drag and Drop, Graphing

Task Model 4

Response Type: Drag and Drop

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

a) Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x-p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b) Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers *a* and *b*.

Evidence Required:
4. The student solves quadratic equations in one variable by

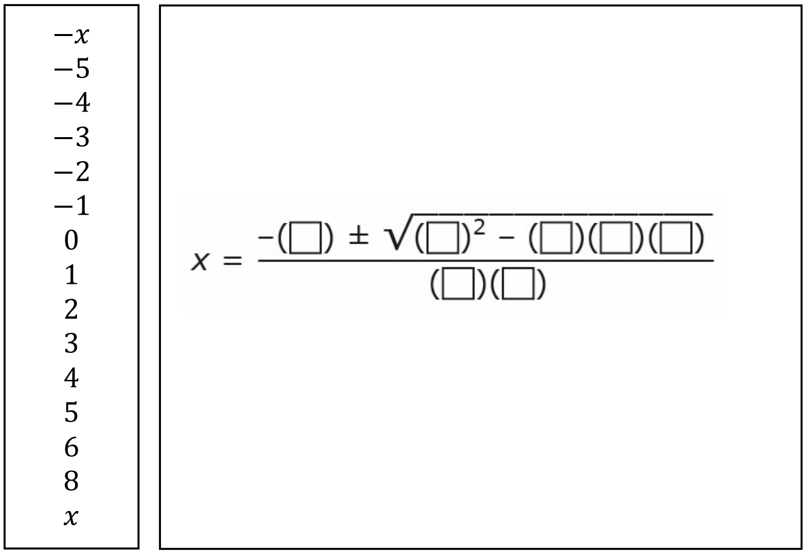
Prompt Features: The student is prompted to rewrite a non-standard quadratic equation into standard form to identify a, b, and c values of the quadratic formula.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The quadratic equation used can:
    - have rational roots
    - irrational roots
    - complex roots
  - The form of the quadratic equation can be
    - standard form, $ax^2 + bx + c = 0$.
    - vertex form, $f(x) = a(x-h)^2 + k$,
    - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4e
Stimulus: The student is given a quadratic equation in non-standard (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$) where a, b, and c are all one-digit numbers

Example Stem: Drag and drop numbers from the list to enter an equivalent equation for $2(x+1)^2 = -3$ into the quadratic formula.



$-x$
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
8
x

$$x = \frac{-(\square) \pm \sqrt{(\square)^2 - (\square)(\square)(\square)}}{(\square)(\square)}$$

Interaction: The student will select and place the correct quadratic formula for the quadratic given.

taking square roots, completing the square, using the quadratic formula, or by factoring. 6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers. **Tools:** None	**Rubric:** (1 point) The student produces the correct quadratic formula (e.g., $x = \frac{-(4)\pm\sqrt{(4)^2-(4)(2)(5)}}{(2)(2)}$). **Response Type:** Drag and Drop

Task Model 4

Response Type:
Drag and Drop

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

a) Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x–p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b) Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers *a* and *b*.

Evidence Required:
4. The student solves quadratic equations in one variable by

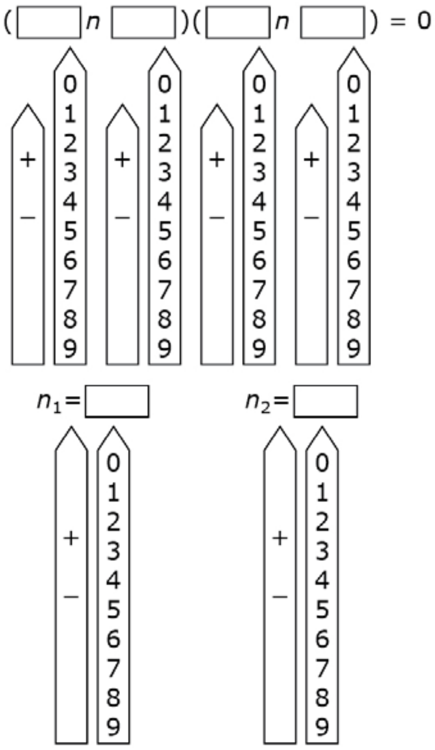
Prompt Features: The student is prompted to setup and solve a quadratic equation using the quadratic formula.

Stimulus Guidelines:

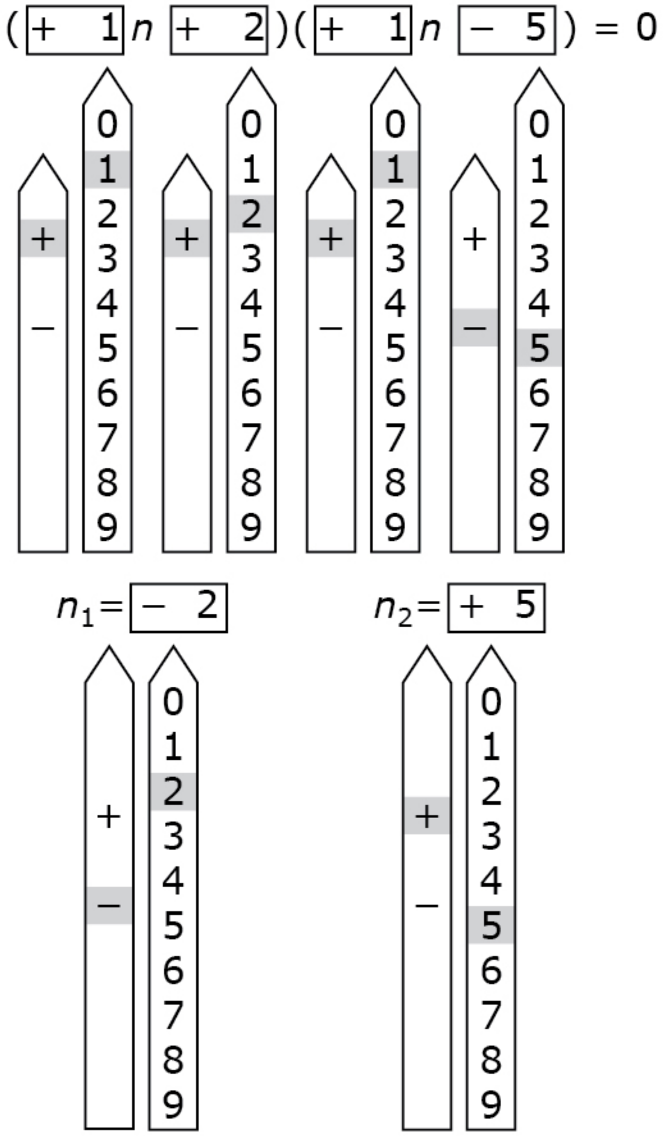
- The quadratic equation used can:
    - have rational roots
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - The form of the quadratic equation can be
        - standard form, $ax^2 + bx + c = 0$.
        - vertex form, $f(x) = a(x - h)^2 + k$,
        - Other non-standard form such as: $\pm bx \pm c = \pm ax^2, \pm c \pm ax^2 = \pm bx$, $\pm ax^2 \pm bx = \pm c$ (e.g., $5(x-3)^2 + 7 = 0$, or $6x - 23 = -3x^2$).

TM4f
Stimulus: The student is presented with a quadratic equation in one variable equivalent to $ax^2 + bx + c = 0$ with *a, b,* and *c* as nonzero integers.

Example Stem: Use the drop down menu to enter an equivalent equation for $n^2 - 3n = 10$ by factoring, and the solutions for *n* (n_1 and n_2).



Interaction: The student will use the drop down menu in

taking square roots, completing the square, using the quadratic formula, or by factoring. 6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers. **Tools:** None	order to make a correct statement about factoring and solving for the two values of *n.* **Rubric:** (2 points) The student correctly factors the equation and provides the correct values for *n*. (1 point) The student correctly factors the equation **or** the student provides both values for *n.*  **Response Type:** Hot Spot

Task Model 5

Response Type: Multiple Choice, single correct response

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

Evidence Required:
5. The student recognizes when the quadratic formula enters complex solutions.

6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers.

Tools: None

Development Note: No more than 5% of this target should come from this task model TM5a.

Prompt Features: The student is prompted to identify the quadratic equation that has no real solutions.

Stimulus Guidelines:

- All quadratic equations for this task model must have complex solutions.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - ▪ Students are asked to identify a quadratic equation with complex solutions, multiple choice.
  - ○ The form of the quadratic equation can be:
    - ▪ standard form, $ax^2 + bx + c = 0$
    - ▪ vertex form, $f(x) = a(x-h)^2 + k$ (e.g., $5(x-3)^2 + 10 = 0$).
    - ▪ other non-standard forms such as: $\pm bx \pm c = \pm ax^2$, $\pm c \pm ax^2 = \pm bx$ or $\pm ax^2 \pm bx = \pm c$ (e.g., $6x - 23 = 3x^2$).

TM5a
Stimulus: The student is presented with multiple quadratic equations in one variable equivalent to $ax^2 + bx + c = 0$ with *a, b,* and *c* as nonzero integers.

Example Stem: Which equation has no real solutions?

A. $4x^2 + 4x - 24 = 0$
B. $x^2 + 4x + 16 = 0$
C. $5x^2 + 3x - 1 = 0$
D. $3x^2 - 4x + 1 = 0$

Rubric:
(1 point) The student selects the correct option (e.g., B).

Response Type: Multiple Choice, single correct response

Task Model 5

Response Type: Multiple Choice, single correct response

DOK Level 2

A-REI.4
Solve quadratic equations in one variable.

Evidence Required:
5. The student recognizes when the quadratic formula enters complex solutions.

6. The student enters complex solutions for the quadratic formula in the form $a \pm bi$ where *a* and *b* are real numbers.

Tools: None

Prompt Features: The student is prompted to solve a quadratic equation using the quadratic formula which results in complex solutions.

Stimulus Guidelines:

- All quadratic equations for this task model must have complex solutions.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
    - Students are asked to identify a quadratic equation with complex solutions, multiple choice.
  - The form of the quadratic equation can be:
    - standard form, $ax^2 + bx + c = 0$
    - vertex form, $f(x) = a(x - h)^2 + k$ (e.g., $5(x - 3)^2 + 10 = 0$).
    - other non-standard forms such as: $\pm bx \pm c = \pm ax^2$, $\pm c \pm ax^2 = \pm bx$ or $\pm ax^2 \pm bx = \pm c$ (e.g., $6x - 23 = 3x^2$).

TM5b
Stimulus: The student is given a quadratic equation with complex roots in standard form : $ax^2 + bx + c = 0$

Example Stem: What are the solutions for the given equation?

$x^2 + 4x + 16 = 0$

A. $x = -2 \pm 4i\sqrt{3}$
B. $x = -2 \pm 2\sqrt{3}$
C. $x = -2 \pm 2i\sqrt{3}$
D. $x = -2 \pm 4\sqrt{3}$

Rubric:
(1 point) The student selects the correct option (e.g., C).

Response Type: Multiple Choice, single correct response

Task Model 1

Response Type:

Multiple Choice, single correct response

DOK Level 1

A-REI.10
Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Evidence Required:
1. The student understands that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Tools: Calculator

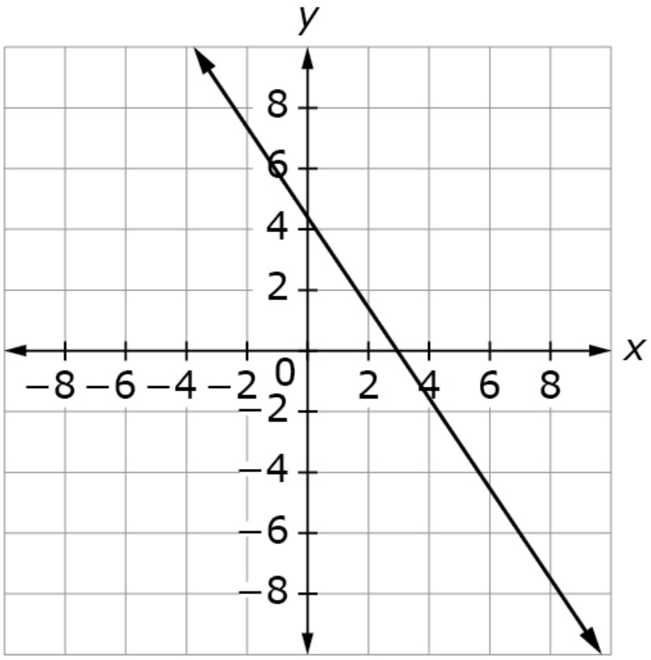
Prompt Features: The student is prompted to determine a solution point to the graph of an equation.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by:
  - varying the order of the equation
  - using integer or real numbers in the solution set

TM1a
Stimulus: The stem will present a Cartesian graph and ask the student to select an ordered pair that is a solution to the equation represented by the graph.

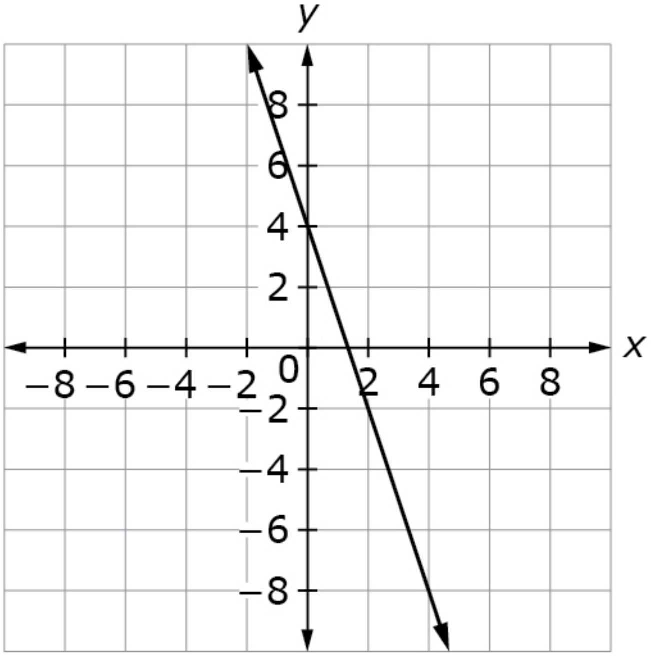
Example Stem 1: Select the ordered pair that is most likely a solution to the equation represented by the graph.



A. (0, 3)
B. (0, 4.5)
C. (2.5, 0)
D. (4.5, 0)

Rubric: (1 point) The student selects the correct ordered pair (e.g., B).

Response Type: Multiple Choice, single correct response

Task Model 1 **Response Type:** **Multiple Choice, single correct response** **DOK Level 1** **A-REI.10** Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). **Evidence Required:** 1. The student understands that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). **Tools:** Calculator	**Example Stem 2:** Select the ordered pair that is most likely a solution to the equation represented by the graph.  A. (4, 0) B. (0, 1.5) C. (6, -14) D. (7, -21) **Rubric:** (1 point) The student selects the correct ordered pair (e.g., C). **Response Type:** Multiple Choice, single correct response

Task Model 1

Response Type:

Multiple Choice, single correct response

DOK Level 2

A-REI.10
Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Evidence Required:
1. The student understands that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Tools: Calculator

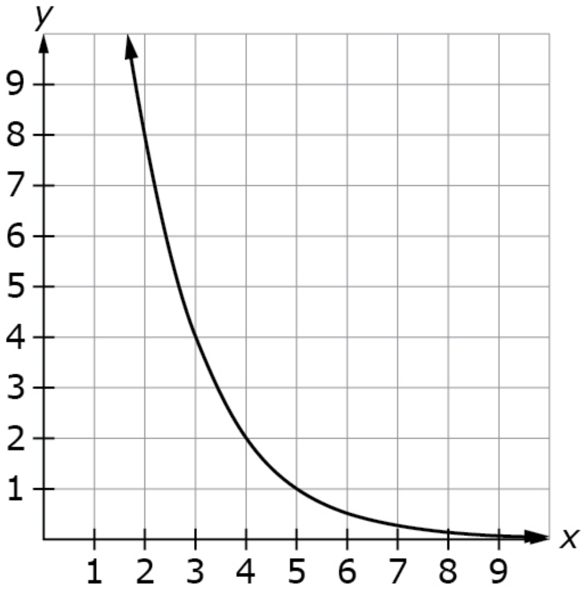
Prompt Features: The student is prompted to determine the correct statement about the solution set of the given graph.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by:
    - varying the order of the equation
    - using integers or real numbers in solution set

TM1b
Stimulus: The student is presented with a graph of a function and its equation.

Example Stem: This graph represents the equation $y = 0.5^{(x-5)}$.



How many solutions are there for the equation in the interval $1 < x < 9$?

A. There are no solutions to the equation in the interval $1<x<9$.
B. There are exactly 2 solutions to the equation in the interval $1<x<9$.
C. There are exactly 7 solutions to the equation in the interval $1<x<9$.
D. There are an infinite number of solutions to the equation in the interval $1<x<9$.

Rubric: (1 point) Student selects the correct statement about the solution set (e.g., D).

Response Type: Multiple Choice, single correct response

Task Model 1

Response Type:
Hot Spot

DOK Level 2

A-REI.10
Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Evidence Required:
1. The student understands that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Tools: Calculator

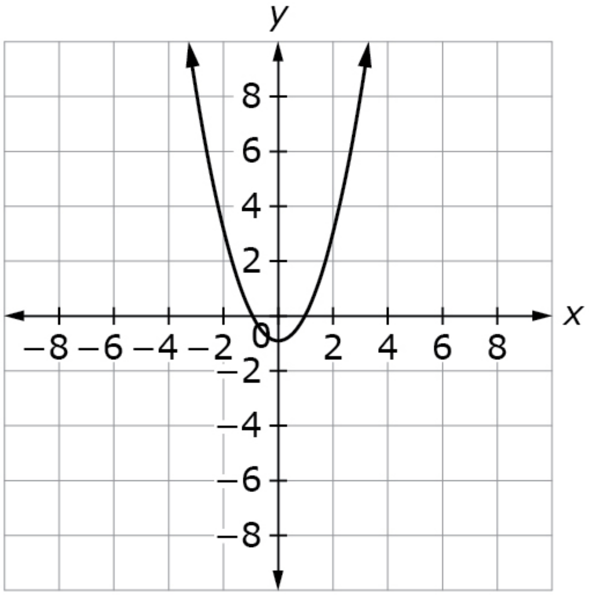
Prompt Features: The student is prompted to determine the consecutive integer interval(s) that contain(s) the *x*- or *y*-coordinates(s) of a point(s) on the graph of a polynomial function.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by:
    - the order of the given polynomial function
    - the number of intervals the student is required to select

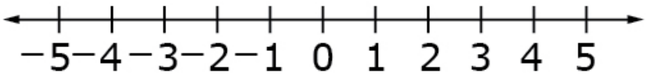
TM1c
Stimulus: The student is presented with a graph of a polynomial, the type of function, and an ordered pair with unknown *x*- or *y*-coordinate.

Example Stem 1: The graph of a quadratic function $y = f(x)$ is shown.



The points (*b,* 13) and (*c,* 13) are both on the graph of this function and *b* ≠*c*.

- Select the consecutive integer interval on the number line that contains the value of *b.*
- Select the consecutive integer interval on the number line that contains the value of *c.*



Task Model 1

Response Type:
Hot Spot

DOK Level 2

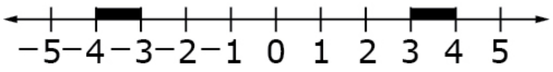
A-REI.10
Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Evidence Required:
1. The student understands that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

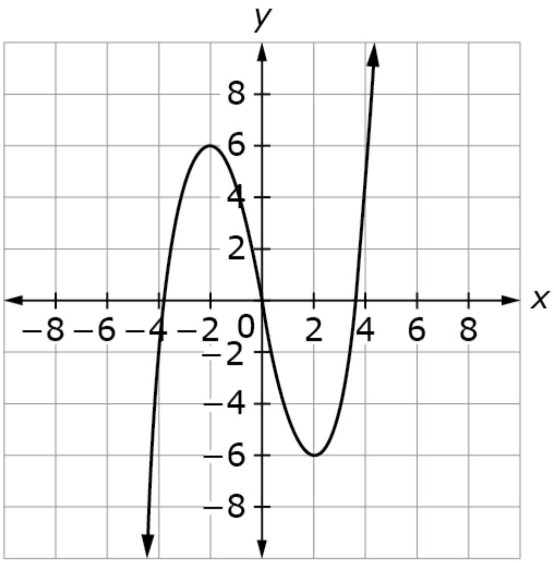
Tools: Calculator

Interaction: The student selects the correct consecutive integer interval(s) on the number line.

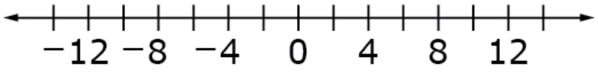
Rubric: (1 point) Student chooses only the correct consecutive integer intervals:



Example Stem 2: The graph of a cubic function $y = f(x)$ is shown.

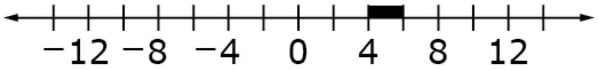


The point *(b,* 13) is on the graph of this function.
Select the smallest integer interval on the number line that contains the value of *b*.



Interaction: The student chooses the correct consecutive integer interval on the number line.

Rubric: (1 point) The student correctly identifies the smallest integer interval possible in which *x* exists.



Response Type: Hot Spot

Task Model 2

Response Type:
Equation/Numeric

DOK Level 1

A–REI.11

Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Evidence Required:
2. The student finds solutions (either exact or approximate as appropriate) to the equation $f(x) = g(x)$ using technology to graph the functions, make tables of values, or find their successive approximations.

Tools: Calculator

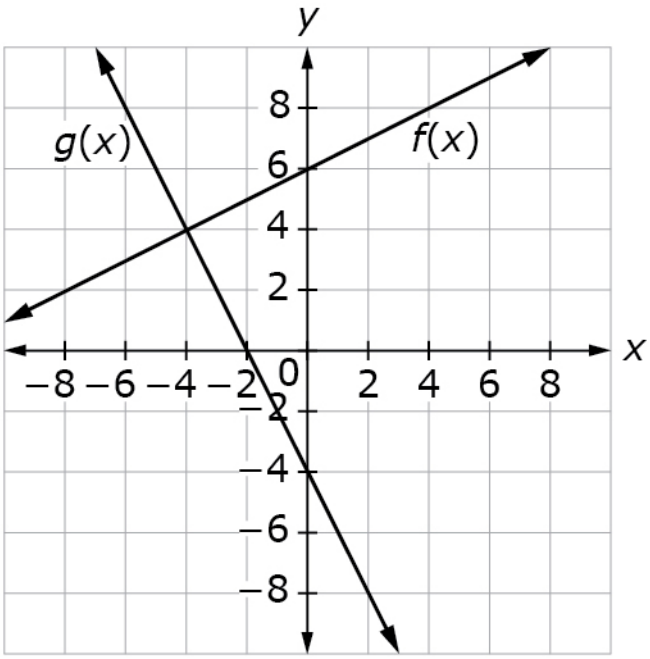
Prompt Features: The student is prompted to determine the *x*-coordinate of the solution point to the graph of two functions.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by varying the order of the functions graphed.

TM2a
Stimulus: The student is presented with a graph in the coordinate plane of two intersecting functions. Functions may or may not be identified.

Example Stem: This graph shows linear equations $y = f(x)$ and $y = g(x)$.



Enter the solution to the equation $f(x) - g(x) = 0$.

Rubric: (1 point) The student correctly enters the *x*-coordinate(s) of the point(s) where the graph of the two functions intersect (e.g., -4).

Response Type: Equation/Numeric

Task Model 2

Response Type: Multiple Choice, multiple correct response

DOK Level 1

A–REI.11
Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Evidence Required:
2. The student finds solutions (either exact or approximate as appropriate) to the equation $f(x) = g(x)$ using technology to graph the functions, make tables of values, or find their successive approximations.

Tools: Calculator

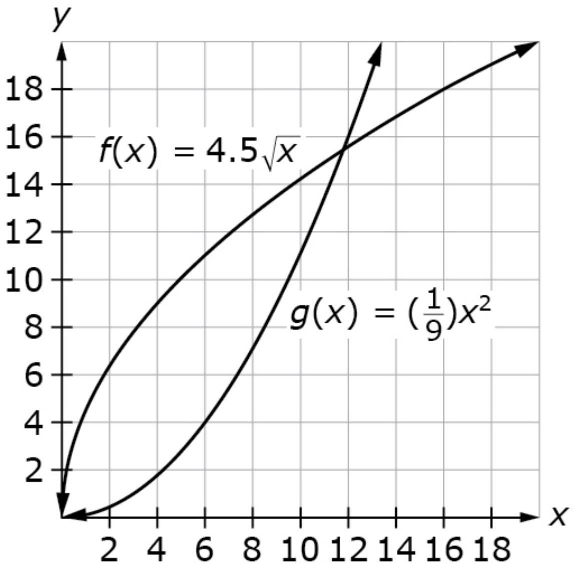
Prompt Features: The student is prompted to select the solution(s) to the equation $f(x) - g(x) = 0$.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real solutions only.
- Item difficulty can be adjusted by varying the order of the functions graphed.

TM2b
Example Stimulus: The stem will present a Cartesian graph of two functions and ask for the student to select the x-coordinate of the point(s) of intersection of the two graphs.

Example Stem 2: This graph shows equations $f(x) = 4.5\sqrt{x}$ and $g(x) = \left(\frac{1}{9}\right)x^2$.



Select **all** answer choices that best represent solutions to the equation $f(x) - g(x) = 0$.

A. *x* = 0
B. *x* = 5.0
C. *x* = 11.7
D. *x* = 13.5
E. *x* = 20.0

Rubric: (1 point) The student correctly enters the *x*-coordinates of the points where the graph of the two functions intersect (e.g., A, C).

Response Type: Multiple Choice, multiple correct response

Task Model 2

Response Type:
Multiple Choice, single correct response

DOK Level 1

A–REI.11

Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Evidence Required:
2. The student finds solutions (either exact or approximate as appropriate) to the equation $f(x) = g(x)$ using technology to graph the functions, make tables of values, or find their successive approximations.

Tools: None

Prompt Features: Identify the graph of $f(x)$ and $g(x)$ and the solutions given the equation $f(x) = g(x)$.

Stimulus Guidelines:

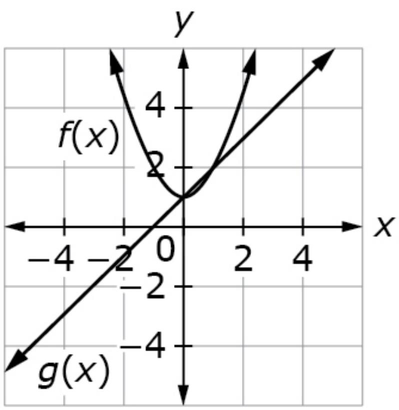
- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by varying the order of the functions graphed.

TM2c

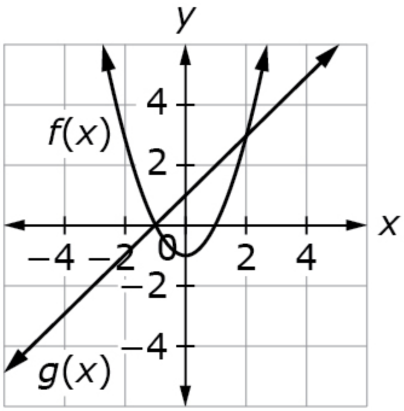
Stimulus: The student is presented with two functions in equation form.

Example Stem: Select the graph with the correct solutions for $f(x) = g(x)$ when $f(x) = x^2 - 1$ and $g(x) = x + 1$.

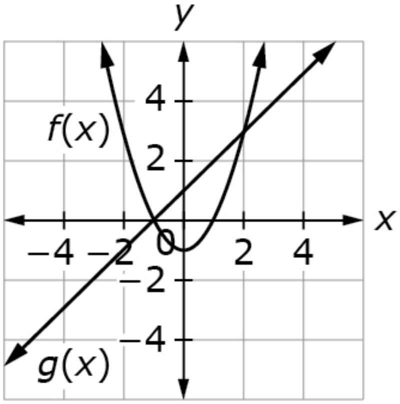
A. $\boldsymbol{x = 0}$, $\boldsymbol{x = 1}$



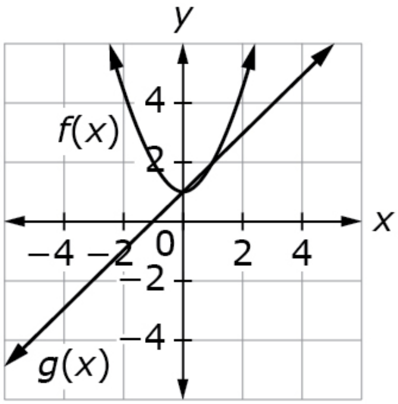
B. $\boldsymbol{x = -1}$, $\boldsymbol{x = 2}$



C. $\boldsymbol{x = 0}$, $\boldsymbol{x = 1}$

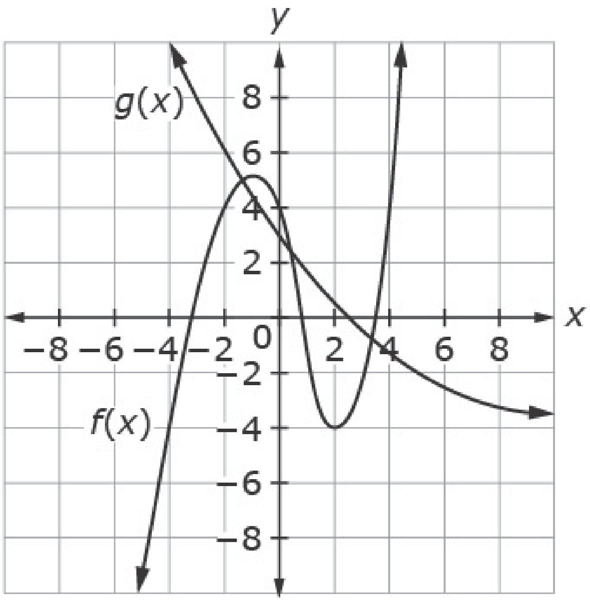


D. $\boldsymbol{x = -1}$, $\boldsymbol{x = 2}$



Rubric: (1 point) The student selects the correct graph of $f(x)$ and $g(x)$ and the solutions to the equation $f(x) = g(x)$ (e.g., B).

Response Type: Multiple Choice, single correct response

Task Model 2 **Response Type:** **Multiple Choice, multiple correct response** **DOK Level 1** **A–REI.11** Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. **Evidence Required:** 2. The student finds solutions (either exact or approximate as appropriate) to the equation $f(x) = g(x)$ using technology to graph the functions, make tables of values, or find their successive approximations. **Tools:** Calculator	**Prompt Feature:** Identify approximate solutions for $f(x) = g(x)$ from the graph of the equations $y = f(x)$ and $y = g(x)$. **Stimulus Guidelines:** • Graphs are on a maximum 20 by 20 grid with scaled and labeled axes. • Real number solutions only. • Item difficulty can be adjusted by varying the order of the functions graphed. **TM2d** **Stimulus:** The student is presented with the graphs of $f(x)$ and $g(x)$ where the solutions are not integers. **Example Stem:** The graph shows a cubic function, $f(x)$, and an exponential function, $g(x)$. Select **all** values that are approximate solutions to the equation $f(x) = g(x)$.  A. *x* = -1.5 B. *x* = -1.1 C. *x* = 0 D. *x* = 0.5 E. *x* = 3.6 **Rubric:** (1 point) Student selects the values that are approximate solutions (e.g., A, D, E). **Response Type:** Multiple Choice, multiple correct response

Task Model 2

Response Type:
Drag and Drop

DOK Level 1

A–REI.11
Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Evidence Required:
2. The student finds solutions (either exact or approximate as appropriate) to the equation $f(x) = g(x)$ using technology to graph the functions, make tables of values, or find their successive approximations.

Tools: Calculator

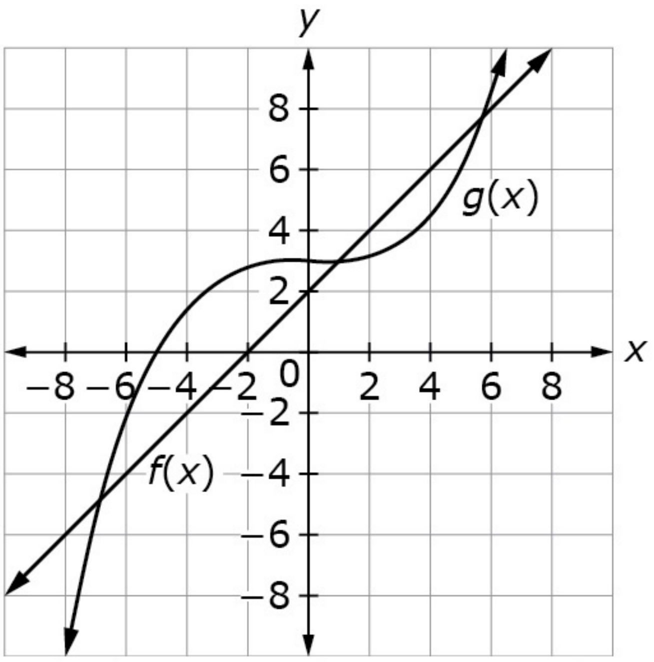
Prompt Features: Given the function graphs for *f*(*x*) and *g*(*x*) student is prompted to drag and drop specific points to correct locations on their graph.

Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by:
  - varying the order of the functions graphed
  - the number of points of intersection of *f*(*x*) and *g*(*x*)

TM2e
Stimulus: The student is presented with a graph in the coordinate plane of two intersecting functions. Functions may or may not be identified.

Example Stem: The graphs of $y = f(x)$ and $y = g(x)$ are shown. Drag three points to the coordinate grid to show a possible location described.

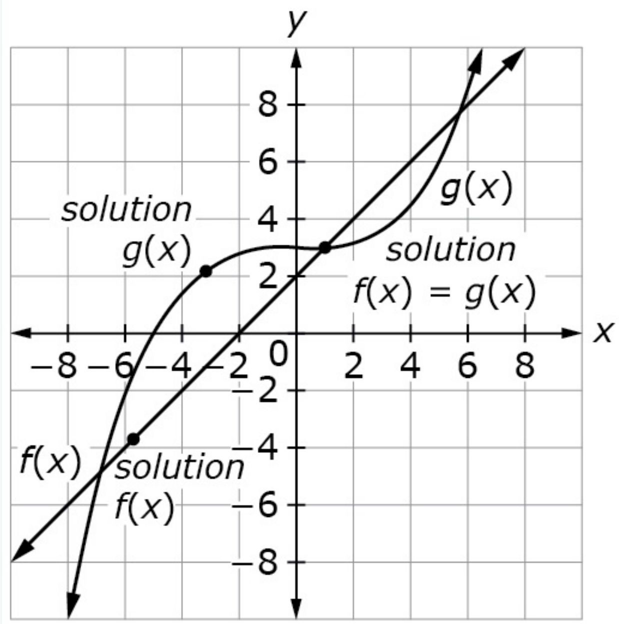


Solution *f*(*x*) Solution *g*(*x*) Solution *f*(*x*) = *g*(*x*)
● ● ●

A) Show the location of a point with coordinates that are a solution to $y = f(x)$ only.
B) Show the location of a point with coordinates that are a solution to $y = g(x)$ only.
C) Show the location of a point with an *x*-coordinate that is a solution to $f(x) = g(x)$

Interaction: The student will drag points to locations on the graph for each solution.

Rubric: (1 point) The student correctly drags the points to appropriate locations on the graph. There are many possible correct responses. Below is one example of a correct response.



Response Type: Drag and Drop

Task Model 3

Response Type:

Multiple Choice, single correct response

DOK Level 1

A–REI.12

Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
3. The student graphs the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality).

Tools: None

Prompt Features: Given a linear inequality in two variables student is prompted to select the corresponding graph.

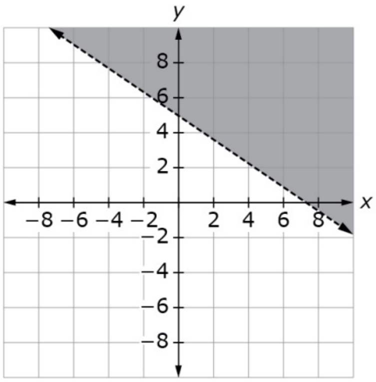
Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- Item difficulty can be adjusted by:
    - varying the level of algebra necessary to obtain a form of the given inequality that can be graphed
    - using integer, rational, or real variable coefficients or constants

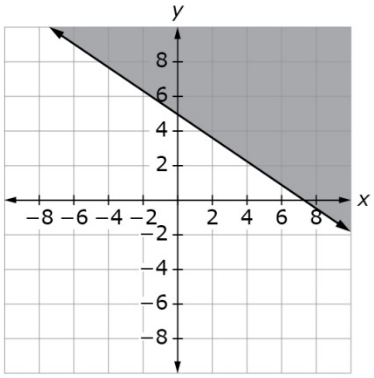
TM3a:
Stimulus: The student is presented with a linear inequality in two variables.

Example Stem: Select the graph that shows the solution set of the linear inequality, $y > -\frac{2}{3}x + 5$.

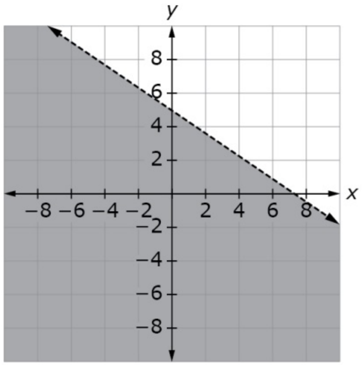
A.



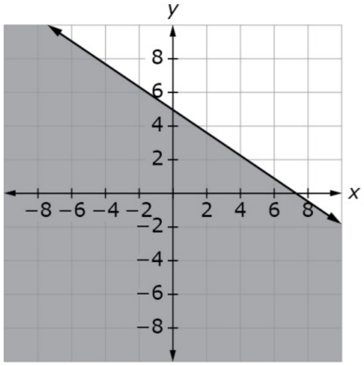
B.



C.

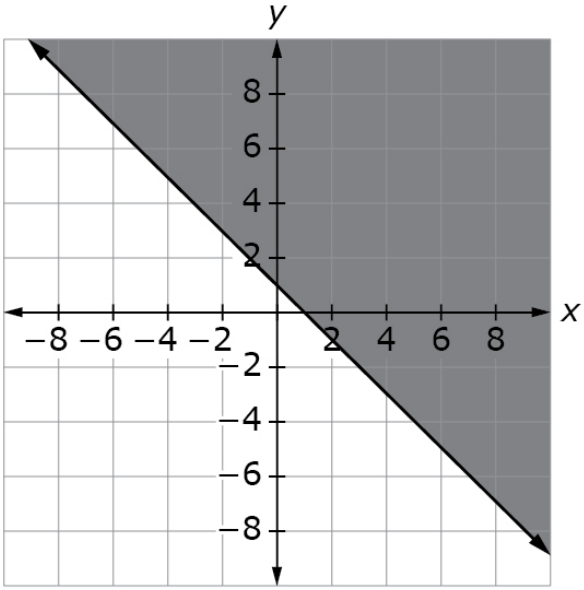


D.



Rubric: (1 point) Student selects the graph for the linear inequality (e.g., A).

Response Type: Multiple Choice, single correct response

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 2** **A–REI.12** Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. **Evidence Required:** 3. The student graphs the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality). **Tools:** None	**Prompt Features:** Given a linear inequality in two variables graphed on the Cartesian Plane student is prompted to enter the corresponding linear inequality. **Stimulus Guidelines: (same as TM3a)** **TM3b:** **Stimulus:** The student is presented with a graph of the solution set of a linear inequality in two variables. **Example Stem:** The graph shown represents the set of ordered pairs that are solutions to an inequality.  Enter the inequality that represents the solution set shown by the graph. **Rubric:** (1 point) Student enters the inequality (e.g., $y \geq -x + 1$). **Response Type:** Equation/Numeric

Task Model 3

Response Type:
Graphing

DOK Level 2

A–REI.12
Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
3. The student graphs the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality).

Tools: None

Prompt Features: Given a linear inequality in two variables student is prompted to graph it on the Cartesian plane and identify a point that is in the solution set of the given linear inequality.

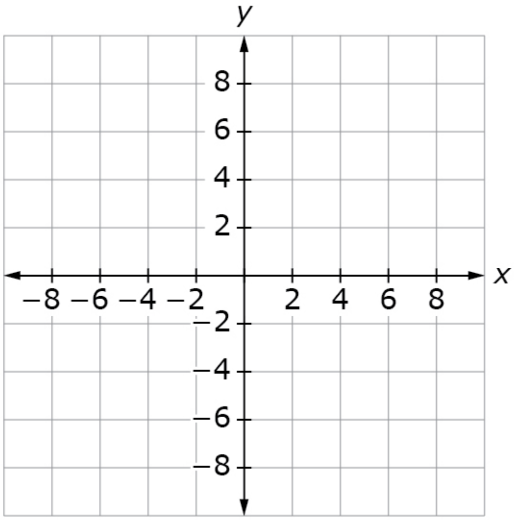
Stimulus Guidelines:

- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- The linear inequality must use ≤ or ≥ and not be a strict inequality.
- Item difficulty can be adjusted by:
    - varying the level of algebra necessary to obtain a form of the given inequality that can be graphed
    - can be adjusted using integer, rational, or real variable coefficients or constants

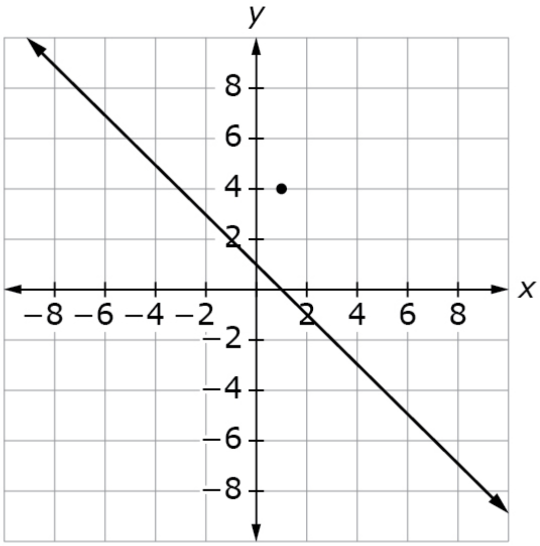
TM3c:
Stimulus: The student is presented with one linear inequality in two variables.

Example Stem:
Part A:
Graph the line representing the boundary of the linear inequality, $x + y \geq 1$.

Part B:
Plot a point representing an ordered pair that is part of the solution set of this inequality.



Interaction: The student uses a graphing tool to draw a line representing the boundary of the inequality. Student then plots a point within the region that represents the solution set of the inequality.

	Rubric: (1 point) Student graphs the equation and plots a point within the solution set.  **Response Type:** Graphing

Task Model 4

Response Type:
Graphing

DOK Level 2

A–REI.12
Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
4. The student will be able to graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Tools: None

Prompt Features: Given a system of linear inequalities in two variables student is prompted to graph them on the Cartesian Plane and plot a point that is in the solution set of the given system.

Stimulus Guidelines:

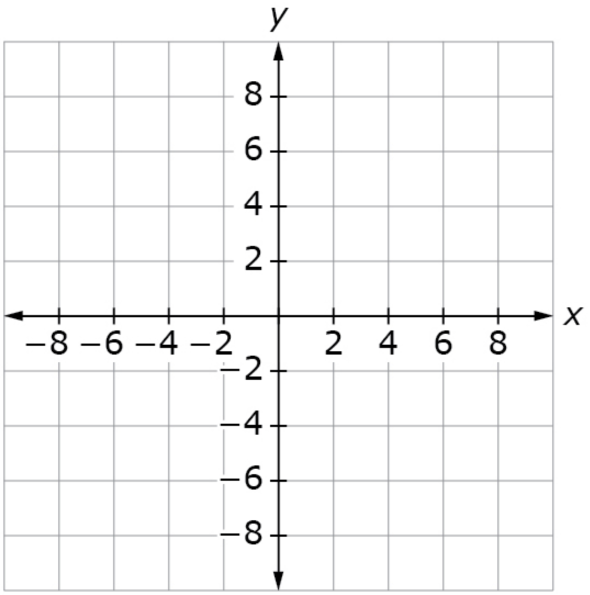
- Graphs are on a maximum 20 by 20 grid with scaled and labeled axes.
- Real number solutions only.
- The linear inequality must use ≤ or ≥ and not be a strict inequality.
- Item difficulty can be adjusted by:
  - varying the level of algebra necessary to obtain a form of the given inequality that can be graphed
  - using integer, rational, or real variable coefficients

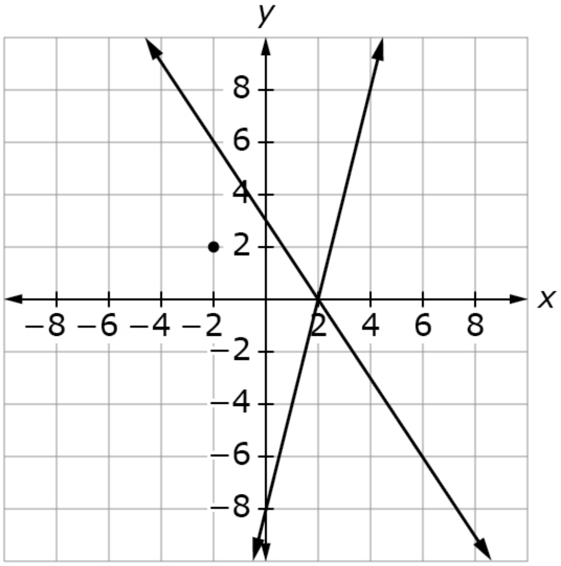
TM4a:
Stimulus: The student is presented with a system of linear inequalities in two variables.

Example Stem:
Part A:
Graph the lines representing the boundaries of the system of linear inequalities.

$3x + 2y \le 6$
$4x - y \le 8$

Part B:
Plot a point within the solution set.



	Interaction: The student uses a graphing tool to draw a line representing the boundary line of each inequality. Student then plots a point within the solution set of the system of inequalities. **Rubric:** (1 point) Student graphs the boundary lines for a system of linear inequalities and plots a point in the region containing the solution set.  **Response Type:** Graphing

Task Model 4

Response Type:
Hot Spot

DOK Level 1

A–REI.12
Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
4. The student will be able to graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Tools: None

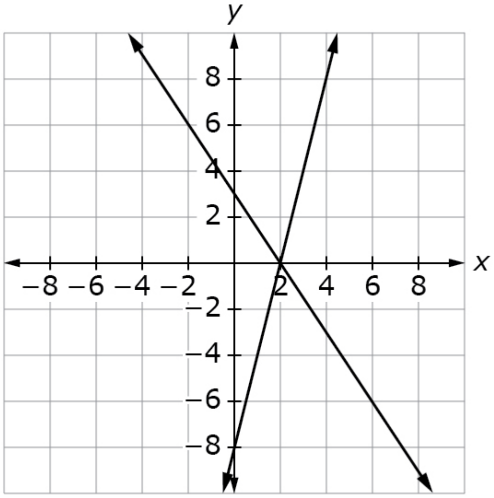
Prompt Features: Given a system of linear inequalities in two variables student is prompted to click on their graph to highlight the region of the graph that represents the solution set of the given system of linear inequalities.

Stimulus Guidelines: (same as TM4a)

TM4b:
Example Stimulus: The student is presented with a system of linear inequalities in two variables.

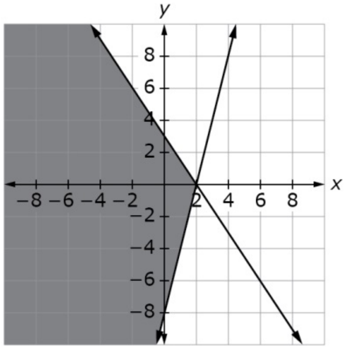
Example Stem: Click on the region of the graph that contains the solution set of the system of linear inequalities.

$3x + 2y \leq 6$
$4x - y \leq 8$



Interaction: The student clicks on the correct region of the graph that contains the solution set to the system of linear inequalities.

Rubric: (1 point) Student correctly selects the region containing the solution set.



Response Type: Hot Spot

Task Model 4

Response Type:

Multiple Choice, single correct response

DOK Level 1

A–REI.12

Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
4. The student will be able to graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Tools: None

Prompt Features: Given a system of linear inequalities in two variables student is prompted to select the corresponding graph representing their solution set.

Stimulus Guidelines: (same as TM4a)

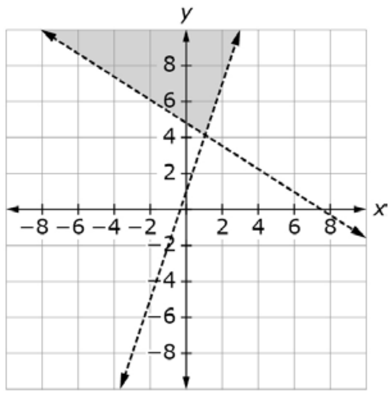
TM4c:
Stimulus: The student is presented with a system of linear inequalities in two variables.

Example Stem: Select the graph that shows the solution set of the system of linear inequalities.

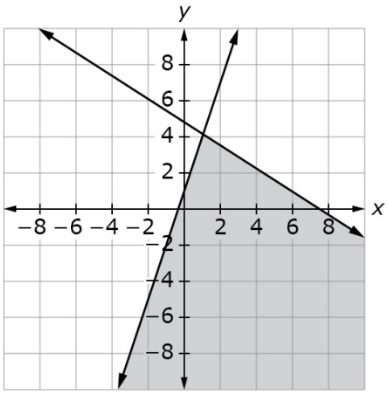
$y > -\frac{2}{3}x + 5$

$y > 3x + 1$

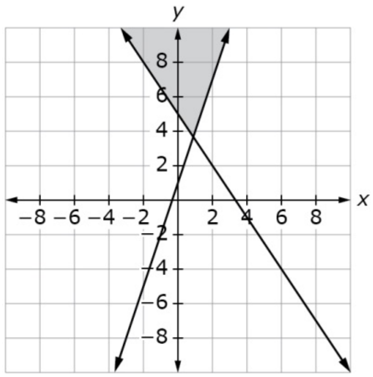
A.



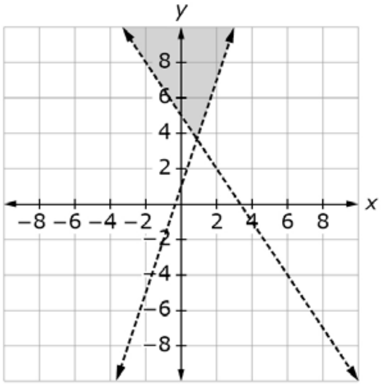
B.



C.



D.



Rubric: (1 point) Student selects the graph given the system of linear inequalities (e.g., A).

Response Type: Multiple Choice, single correct response

Task Model 4

Response Type:
Graphing; Hot Spot

DOK Level 2

A–REI.12

Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Evidence Required:
4. The student will be able to graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Tools: None

Prompt Features: Given a system of linear inequalities in two variables student is prompted to graph the system and select points that are in the solution set of the system.

Stimulus Guidelines: (same as TM4a)

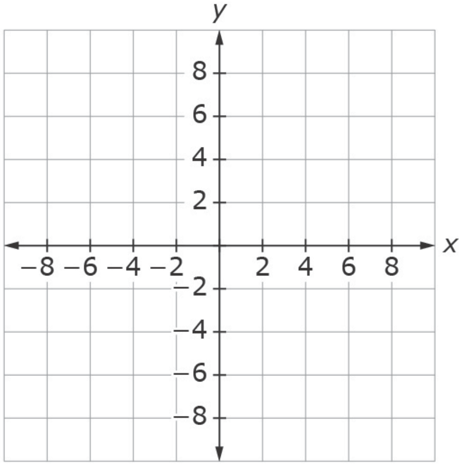
TM4d:
Example Stimulus: The student is presented with a system of linear inequalities in two variables.

Example Stem:
Part A:
Graph the lines representing the boundaries of the system of linear inequalities.

$3x + 2y \le 6$
$4x - y \le 8$

Part B:
Determine if each ordered pair is a part of the solution set of the system of linear inequalities. Select the ordered pair(s) that are in the solution set.

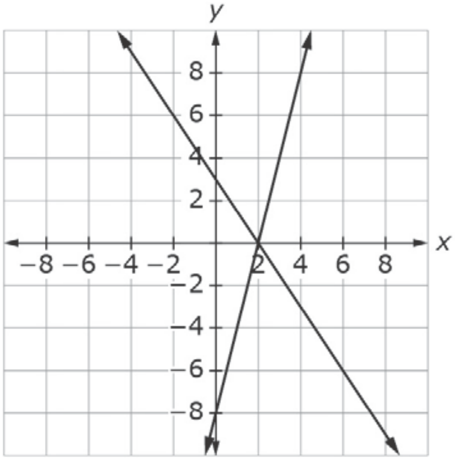
Part A



Part B
(−4, 4) (−4, 0) (0, 4) (0, −4) (4, 0)

Interaction: The student uses a graphing tool to draw a line representing the boundary line of each inequality. Student then selects if each ordered pair is within the solution set.

Rubric: (2 points) The student graphs the boundary lines for a system of linear inequalities correctly and selects the ordered pairs in the solution set.
(1 point) The student graphs the boundary lines for a system of linear inequalities correctly or selects the ordered pairs in the solution set.

	Part A  **Part B** [✓ (−4, 4)] [✓ (−4, 0)] (0, 4) [✓ (0, −4)] (4, 0) **Response Type:** Graphing; Hot Spot

Task Model 1

Response Type: Multiple Choice, multiple correct response

DOK Level 1

F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f(x)*.

Evidence Required:
1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions).

Tools: Calculator

Prompt Features: Distinguish between functions and non-functions based on recognizing that each element of the domain maps to exactly one element of the range.

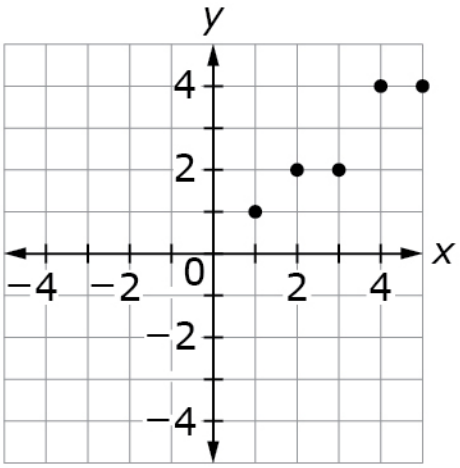
Stimulus Guidelines: The student is prompted to select which of a selection of graphs represent functions.

- Graphs throughout should be properly identified (e.g., $f(x) = y$).
- Graph may be linear, quadratic, rational, or piece-wise functions.
- Scale dimensions: *x*-min: -10, *x*-max: 10, *y*-min: -10, *y*-max: 10
- Item difficulty can be adjusted by varying the type of functions and non-functions represented by the graphs.

TM1a
Stimulus: The student is presented with six graphs, representing a variety of functions and non-functions.

Example Stem 1: Select **all** graphs that are graphs of functions.

A.



<table>
<tr>
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Task Model 1

Response Type: Multiple Choice, multiple correct response

DOK Level 1

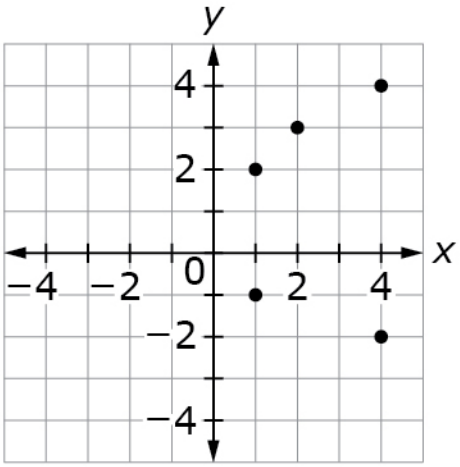
F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f(x)*.

Evidence Required:
1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions).

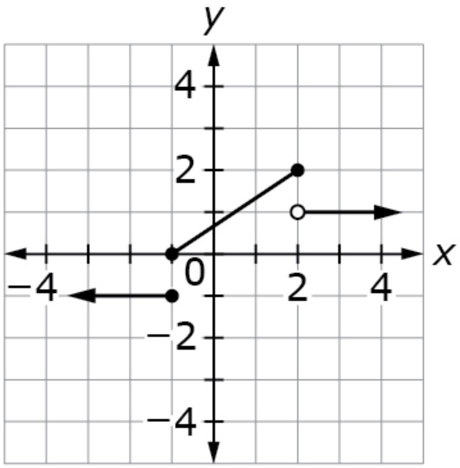
Tools: Calculator

</td>
<td>

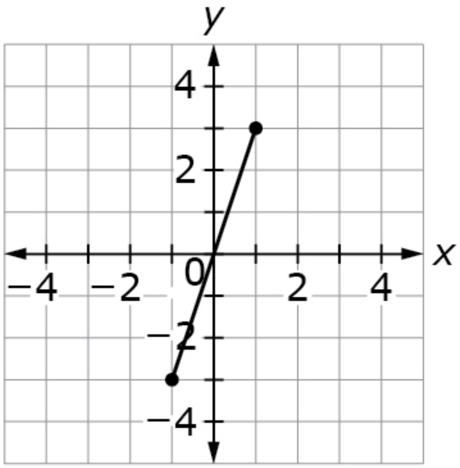
B.



C.



D.



</td>
</tr>
</table>

<table>
<tr>
<td>

Task Model 1

Response Type: Multiple Choice, multiple correct response

DOK Level 1

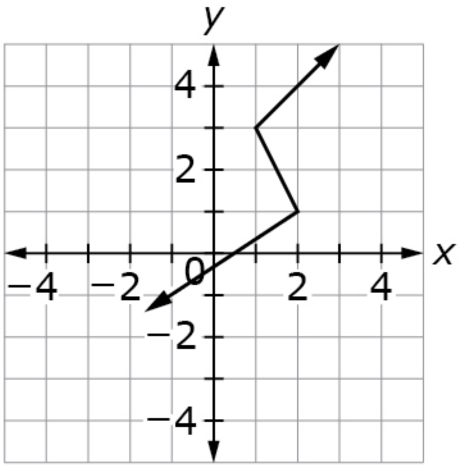
F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f(x)*.

Evidence Required:
1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions).

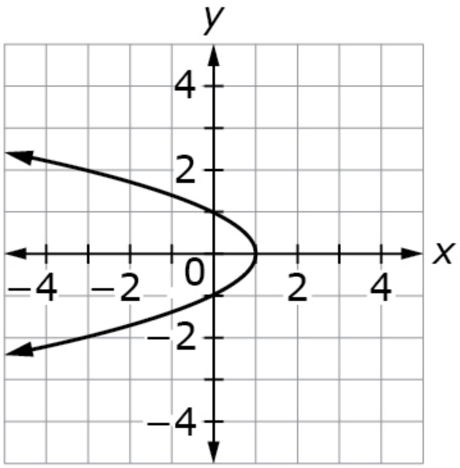
Tools: Calculator

</td>
<td>

E.



F.



Rubric: (1 point) The student correctly selects all graphs of functions (e.g., A, D).

Response Type: Multiple Choice, multiple correct response

</td>
</tr>
</table>

Task Model 1

Response Type: Multiple Choice, multiple correct response

DOK Level 1

F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f(x)*.

Evidence Required:
1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions).

Tools: Calculator

Prompt Features: Distinguish between functions and non-functions based on recognizing that each element of the domain maps to exactly one element of the range.

Stimulus Guidelines: The student is prompted to select which of a selection of equations represent functions.

- There should be no fewer than four and no more than six answer choices.
- Item difficulty can be adjusted by varying the complexity of the equations.

TM1b
Stimulus: The student is presented with equations representing a variety of functions and non-functions. Equations may be linear, quadratic, polynomials, or absolute value. Students may graph or perform algebraic manipulations to check.

Example Stem: Select **all** equations that are equivalent to an equation that expresses *y* as a function of *x*.

A. $3x - 4y = -2$

B. $x - y^4 = 0$

C. $x^2 - 3y = 0$

D. $|x| + |y| = 2$

Rubric: (1 point) The student correctly selects all options that represent *y* as a function of *x* (e.g., A, C).

Response Type: Multiple Choice, multiple correct response

Task Model 1 **Response Type: Multiple Choice, multiple correct response** **DOK Level 2** **F-IF.1** Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then $f(x)$ denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation $y = f(x)$. **Evidence Required:** 1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions). **Tools:** Calculator	**Prompt Features:** Distinguish between functions and non-functions based on recognizing that each element of the domain maps to exactly one element of the range. **Stimulus Guidelines:** The student is prompted to select which statements are true or false, given the domain and range of a function. • There should be no fewer than four and no more than six answer choices. • Item difficulty can be adjusted by varying the information about the domain and range of the function. **TM1c** **Stimulus:** The student is presented with the domain and range of a function $f(x)$, as well as two given values of the function. **Example Stem:** A function, $f(x)$, has domain $-10 \le x \le 20$ and range $-40 \le f(x) \le -10$. $f(1) = -13$ $f(-10) = -40$ Select each statement that **must be false** about $f(x)$. A. $f(1) = 13$ B. $f(-9) = 88$ C. $f(5) = -40$ D. $f(0) = 0$ E. $f(-15) = -20$ **Rubric:** (1 point) The student correctly selects all valid options based on the stem (e.g., A, B, D, E). **Response Type:** Multiple Choice, multiple correct response

Task Model 1

Response Type: Matching Tables

DOK Level 1

F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation $y = f(x)$.

Evidence Required:
1. The student understands that a function from one set (the domain) to another set (the range) assigns to each element of the domain exactly one element of the range (e.g., distinguish between functions and non-functions).

Tools: Calculator

Prompt Features: Distinguish between functions and non-functions based on recognizing that each element of the domain maps to exactly one element of the range.

Stimulus Guidelines: the student is presented with several data tables and prompted to select which might represent functions.

- The tables should contain no fewer than four and no more than six pairs of data values.
- Item difficulty can be adjusted by varying the size of the tables and the complexity of the data in the tables.

TM1d
Stimulus: The student is presented with three or four data tables.

Example Stem: Some students are studying graphs of functions $y= f(x)$ and other equations. Each table contains some points on a particular graph. Decide whether each set of points **might be** on the graph of a function or **cannot be** on the graph of a function.

<table>
<tr><th></th><th>Yes
These points
might be</th><th>No
These points
cannot be</th></tr>
<tr><td>A.<table><tr><td><i>x</i></td><td>0</td><td>1</td><td>1</td><td>4</td><td>4</td></tr><tr><td><i>y</i></td><td>0</td><td>3</td><td>4</td><td>3</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td>B.<table><tr><td><i>x</i></td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td><i>y</i></td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td>C.<table><tr><td><i>x</i></td><td>-2</td><td>0</td><td>1</td><td>3</td><td>4</td></tr><tr><td><i>y</i></td><td>3</td><td>3</td><td>3</td><td>3</td><td>3</td></tr></table></td><td></td><td></td></tr>
</table>

Rubric: (1 point) The student correctly identifies the true statement (e.g. NYY).

Response Type: Matching Tables

Task Model 2

Response Type:
Matching Tables

DOK Level 2

F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f(x)*.

Evidence Required:
2. The student understands that if *f* is a function and *x* is an element of its domain, then *f*(*x*) denotes the output of *f* corresponding to the input of *x*.

Tools: None

Prompt Features: Determine any necessary restriction that needs to be placed on the domain in order for an equation to represent a function.

Stimulus Guidelines:

- All numbers, variables, and operations should be changed to create an item. Follow any stated guidelines on allowable number ranges, etc.
- Difficulty level can be altered by varying the type of functions.

TM2
Stimulus: The student is presented with four equations that are solved for *f(x)* and directed to match the domain that would define the equation as a function.

Example Stem: Select the domain for which each function is defined.

Function	All real numbers	x ≠ 2	x ≤ 2	x ≥ 2
$f(x) = \sqrt{2-x}$				
$f(x) = \sqrt[3]{(x+2)}$				
$f(x) = \frac{x^2}{x-2}$				
$f(x) = \frac{\sqrt{x-2}}{x^3}$				

Rubric: (1 point) The student correctly matches the domain to its equation.

Function	All real numbers	x ≠ 2	x ≤ 2	x ≥ 2
$f(x) = \sqrt{2-x}$			▨	
$f(x) = \sqrt[3]{(x+2)}$	▨			
$f(x) = \frac{x^2}{x-2}$		▨		
$f(x) = \frac{\sqrt{x-2}}{x^3}$				▨

Response Type: Matching Tables

Task Model 3

Response Type: Graphing

DOK Level 2

F-IF.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation $y = f(x)$.

Evidence Required:
3. The student understands that the graph of *f* is the graph of the equation $y = f(x)$.

Tools: None

Prompt Features: The student understands that the graph of *f* is the graph of the equation $y = f(x)$.

Stimulus Guidelines:

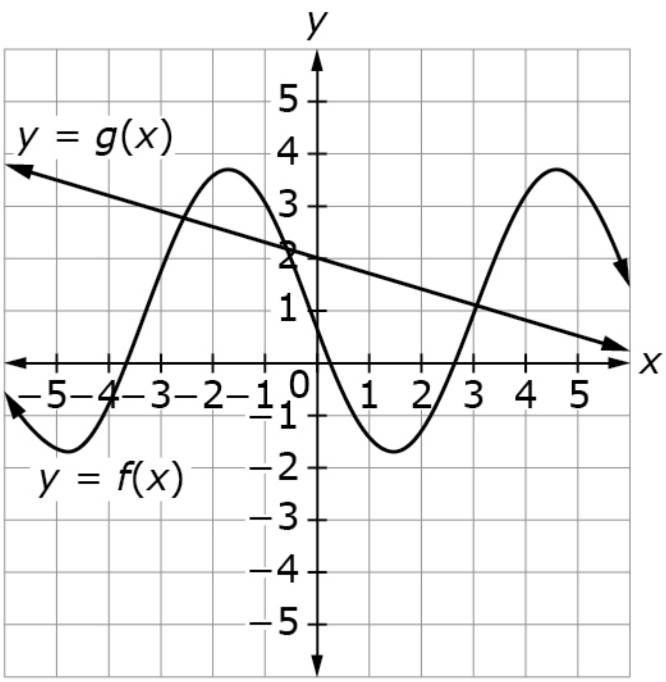
- All function graphs and function values should be changed to create an item.
- Difficulty level can be altered by varying the type of functions graphed.

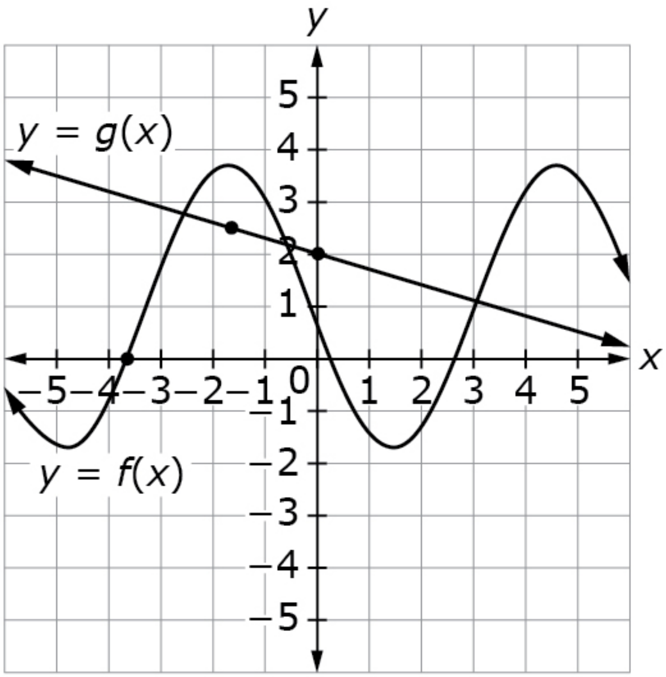
TM3
Stimulus: The student is presented with one or two functions and directed to use the "Add Point" tool to plot points that lie on those functions. If two functions are used, the item may be worth two points.

Example Stem:
The graphs of $y = g(x)$ and $y = f(x)$ are shown.

Use the "Add Point" tool to add a point that will satisfy each given condition.

- A point on the graph of *g* where $x=0$.
- A point on the graph of *g* where $f(x) > g(x)$.
- A point on the graph of *f* where $f(x) = 0$.



	Rubric: (2 points) The student correctly plots points defined by the conditions (e.g., A: The *y*-intercept of *g*; B: Any point on the graph of *g* sitting under the graph of *f*; C: Any of the three points where the graph of *f* crosses the *x*-axis). (1 point) The student correctly plots two of the three points defined by the conditions.  **Response Type:** Graphing **Source:** Adapted from Illustrative Mathematics

Task Model 4 **Response Type: Multiple Choice, single correct response** **DOK Level 1** **F-IF.3** Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.* **Evidence Required:** 4. The student recognizes that sequences are functions whose domain is a subset of the integers. **Tools:** None	**Prompt Features:** The student recognizes that sequences are functions whose domain is a subset of the integers. **Stimulus Guidelines:** • All sequences should be changed to create an item. • The domain of each function should be {1, 2, 3, 4, 5}. • Difficulty level can be altered by varying the complexity of the sequence. **TM4** **Stimulus:** The student is presented with five terms of a sequence. **Example Stem:** Consider a sequence whose first five terms are 6, 12, 24, 48, 96. Select the function (with domain of all integers *n*≥1) that can be used to define and continue this sequence. A. $f(n) = 6n$ B. $f(n) = 6(n-1)$ C. $f(n) = 6n^2$ D. $f(n) = 6(2)^{n-1}$ **Rubric:** (1 point) The student correctly identifies the equation of the function defined by the sequence (e.g., D). **Response Type:** Multiple Choice, single correct response

Task Model 1

Response Type: Matching Tables

DOK Level 1

F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
1. The student interprets key features of a graph or a table representing a function modeling a relationship between two quantities.

Tools: Calculator

Prompt Features: The student is prompted to identify true statements regarding key features of a given graph or table representing a function that models a relationship between two quantities. The statements will be in the context of the relationship being modeled. Key features include the following:

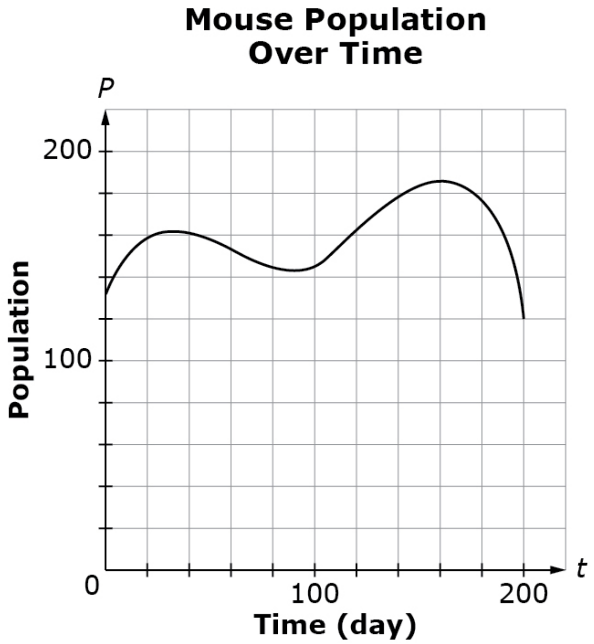
- intercepts
- intervals where the function is increasing or decreasing, positive or negative
- relative maximums and minimums
- symmetries
- asymptotes or end behavior
- periodicity

Stimulus Guidelines:

- Graph or table represents a function that increases or decreases the same amount (additively or multiplicatively) over each interval of the same length (e.g., linear or exponential).
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - The graph or table represents a constantly increasing or decreasing function (e.g., linear or exponential).
  - The graph or table represents a function with either one relative maximum or minimum (e.g., quadratic).
  - The graph or table represents a function with multiple relative maximums or minimums.

TM1a
Stimulus: The student is given a graph or table representing a function that models the relationship between two quantities in a real world situation familiar to 15- to 17-year-olds, e.g., temperature change over time, or population change over a period of time.

Example Stem 1: This graph shows the population of mice in a study, modeled as a function of time. The study begins on day 0.



Task Model 1

Response Type: Matching Tables

DOK Level 1

F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
1. The student interprets key features of a graph or a table representing a function modeling a relationship between two quantities.

Tools: Calculator

Determine whether each statement is true according to the graph. Select True or False for each statement.

Statement	True	False
The mouse population was decreasing between day 40 and day 80.		
The least number of mice during the study was 130.		
The mouse population was at its greatest around day 160.		
There are two intervals where the mouse population is decreasing.		

Rubric: (1 point) The student correctly selects the true and false interpretations of key features represented by the graph or table (e.g. T, F, T, T).

Example Stem 2: This table shows the relationship between the height of a ball and its horizontal distance from the starting point when it is kicked from ground level into the air.

Horizontal Distance from Starting Point (ft)	0	2.5	3	5	6.5	8	10	10.5	13
Height (ft)	0	52.5	60	80	84.5	80	60	52.5	0

Determine whether each statement is true according to the table. Select True or False for each statement.

Statement	True	False
The height of the ball decreased from a distance of 2.5 to 6.5 feet from the starting point.		
The height of the ball was at its greatest when it was approximately 6.5 feet away from the starting point.		
The ball was on the ground exactly one time.		

Rubric: (1 point) The student correctly selects the true and false interpretations of key features represented by the graph or table (e.g. F, T, F).

Response Type: Matching Tables

Task Model 1

Response Type: Hot Spot

DOK Level 1

F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
1. The student interprets key features of a graph or a table representing a function modeling a relationship between two quantities.

Tools: Calculator

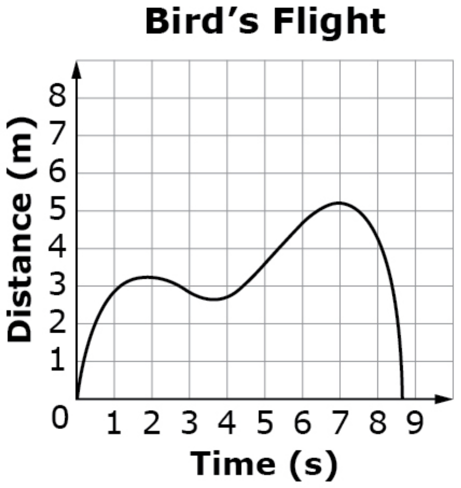
Prompt Features: The student is prompted to identify points on a given graph that correspond to key features of events within a contextual situation. The graph is the representation of a function modeling the contextual situation. Key features include the following:

- intercepts
- intervals where the function is increasing or decreasing, positive or negative
- relative maximums and minimums
- symmetries
- asymptotes or end behavior
- periodicity

Stimulus Guidelines: (same as TM1a)

TM1b
Stimulus: The student is given a graph representing a function that models the relationship between two quantities in a real world situation familiar to 15- to 17-year-olds, e.g., temperature change over time, or population change over a period of time.

Example Stem: A bird flies out of its nest. This graph represents the distance it flies from its nest (in meters) as a function of time (in seconds).



Drag the star to mark the point on the graph that represents the bird's greatest distance from its nest. Then drag the circle to mark the point that represents the bird's return to its nest.

Interaction:
The student drags the star and circle to the correct points on the graph.

Rubric: (1 point) The student correctly identifies the point representing the bird's farthest distance from the nest and the point where the bird returns [e.g., approximately (7, 5.2) and (8.7, 0)].

Response Type: Hot Spot

Task Model 2

Response Type: Graphing

DOK Level 2

F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
2. The student sketches graphs showing key features given a verbal description of a relationship between two quantities that can be modeled with a function.

Tools: Calculator

Prompt Features: The student is prompted to sketch a graph (or points on a graph) showing key features given a verbal description of a relationship between two quantities. Key features include the following:

- intercepts
- intervals where the function is increasing or decreasing, positive or negative
- relative maximums and minimums
- symmetries
- asymptotes or end behavior
- periodicity

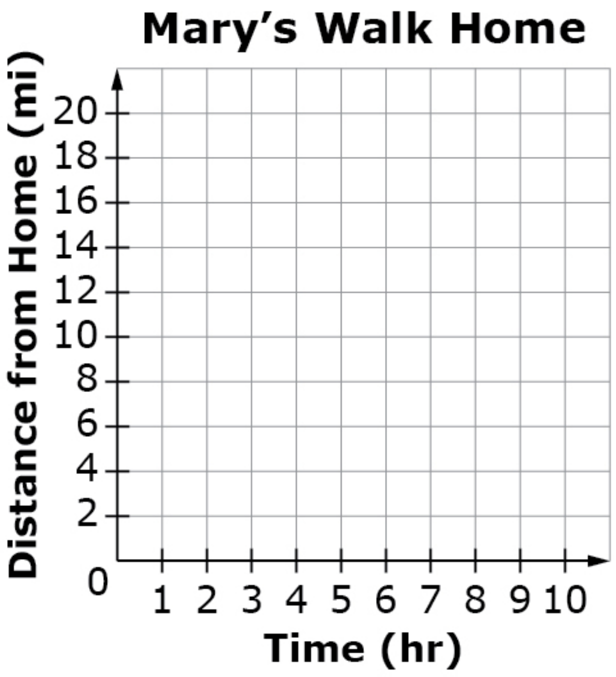
Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - A linear relationship that includes
    - a rate and an intercept, or
    - two intercepts.

TM2
Stimulus: The student is presented with a contextual situation, familiar to 15- to 17-year-olds, where a function can model a relationship between two quantities.

Example Stem 1: Mary is 10 miles from her home.

- She is returning home, walking at a constant speed of 2 miles per hour.
- Her distance from home can be modeled as a function of time.



Use the Add Point and Connect Line tools to graph Mary's distance from home as a function of time.

Task Model 2

Response Type: Graphing

DOK Level 2

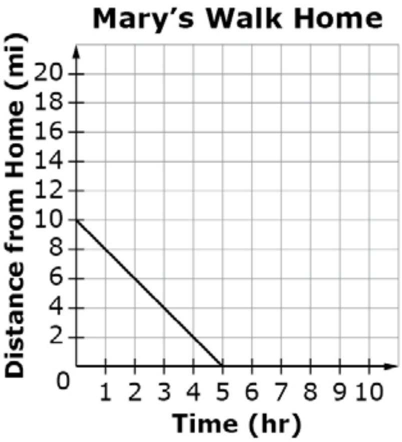
F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
2. The student sketches graphs showing key features given a verbal description of a relationship between two quantities that can be modeled with a function.

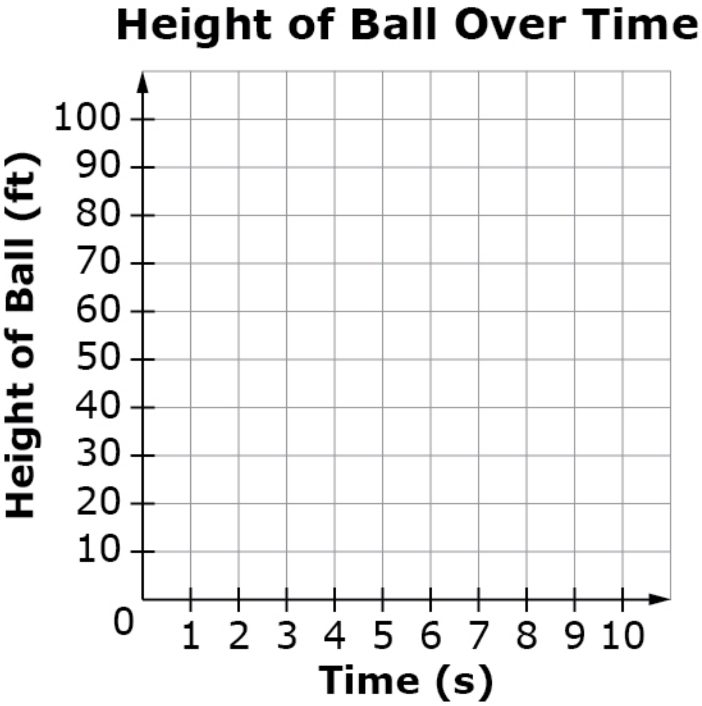
Tools: Calculator

Interaction: The student uses the Add Point tool to place points on the grid, and the Connect Line tool to connect the points.

Rubric:
(1 point) The student creates the graph correctly (see below).



Example Stem 2: A ball is on the ground. Jon kicks the ball into the air. Assume that the height of the ball can be modeled as a quadratic function with respect to time. It reaches a maximum height of 64 feet and lands on the ground 4 seconds later.



Use the Add Point tool to plot the points on the grid that represent

- when John kicks the ball,
- the ball at its highest point, and
- when the ball lands on the ground.

Task Model 2

Response Type:
Graphing

DOK Level 2

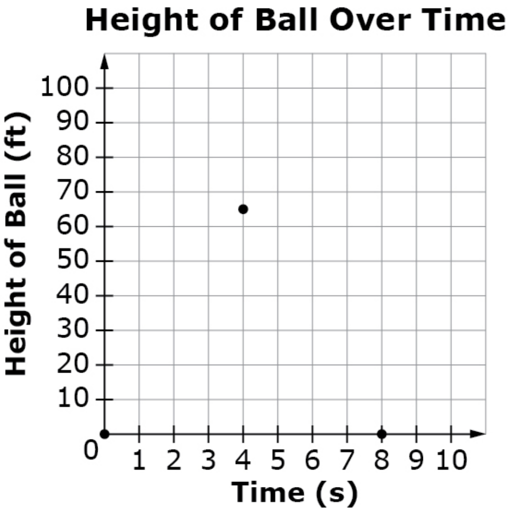
F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
2. The student sketches graphs showing key features given a verbal description of a relationship between two quantities that can be modeled with a function.

Tools: Calculator

Interaction: The student uses the Add Point tool to place points on the grid.

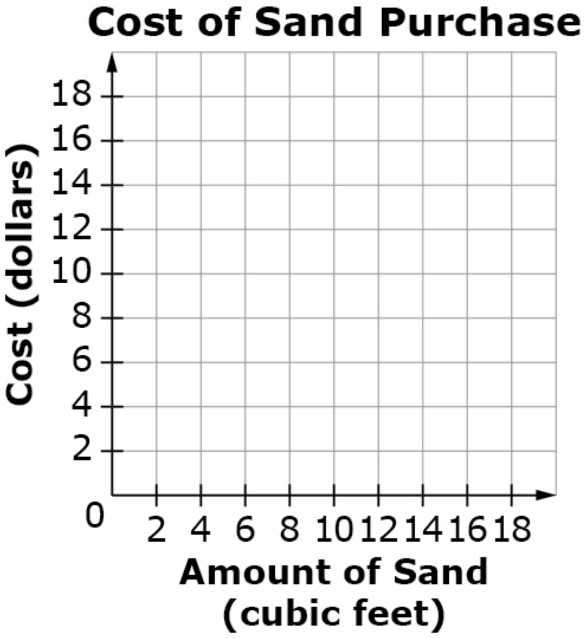
Rubric:
(1 point) The student plots the points correctly (see below).



Example Stem 3: A company is building a playground and needs to buy sand. The cost of sand is a function of the amount of sand purchased.

- The first 5 cubic feet cost $1.50 per cubic foot.
- An amount greater than 5 cubic feet and less than or equal to 10 cubic feet costs $1.25 per cubic foot.
- An amount over 10 cubic feet costs $1.00 per cubic foot.

Use the Add Point and Connect Line tools to create a graph to show the total cost of the sand (in dollars) as a function of the amount of sand purchased (in cubic feet).



Task Model 2

Response Type:
Graphing

DOK Level 2

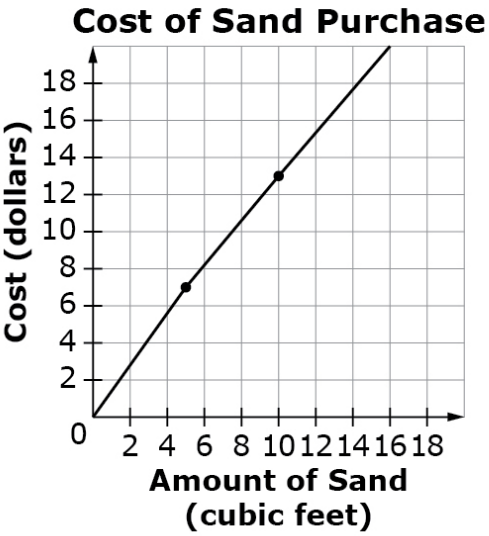
F-IF.4
For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Evidence Required:
2. The student sketches graphs showing key features given a verbal description of a relationship between two quantities that can be modeled with a function.

Tools: Calculator

Interaction: The student uses the Add Point tool and Connect Line tool to graph the linear segments of a piecewise function on the grid.

Rubric:
(1 point) The student creates the graph correctly.



Response Type: Graphing

Task Model 3

Response Type: Multiple Choice, single correct response

DOK Level 2

F-IF.5
Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

Evidence Required:
3. The student relates the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

Tools: Calculator

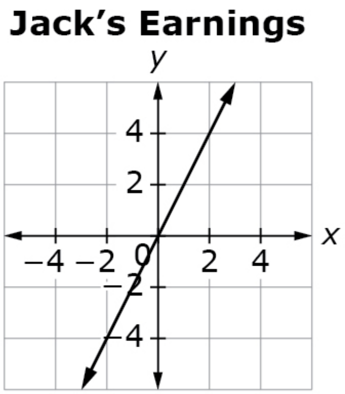
Prompt Features: The student is prompted to identify the graph representing the domain of a function given a contextual situation.

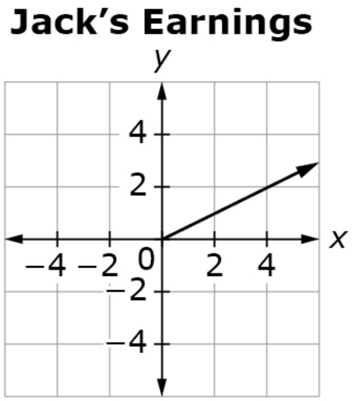
Stimulus Guidelines:

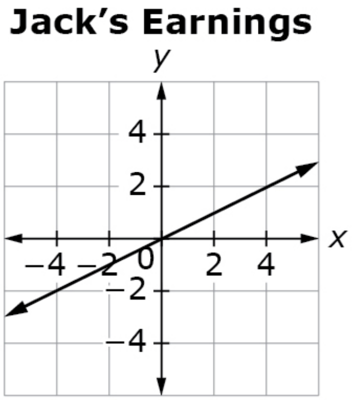
- The graphs must represent linear, quadratic, and other polynomial functions defined by a context and apply appropriate labels and scales.
- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - Representing a linear function
  - Representing a quadratic function
  - Representing an exponential function
  - Representing a trigonometric function

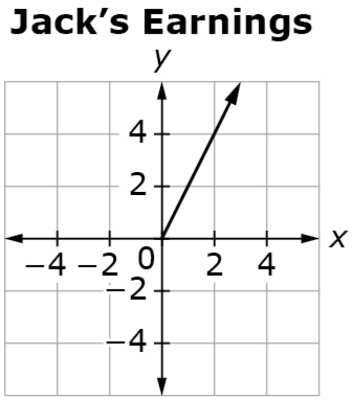
TM3a
Stimulus: The student is presented with four graphs of a function in the coordinate plane, with the graphs in various intervals of positive and negative *x*-values.

Example Stem: Select the graph that correctly represents the amount of money, *y*, Jack earns doing chores for *x* hours at $2 an hour if he works for a maximum of 8 hours.

A.


B.


C.


D.


Rubric: (1 point) The student identifies the correct graph (e.g., D).

Response Type: Multiple Choice, single correct response

Task Model 3

Response Type: Multiple Choice, single correct response

DOK Level 2

F-IF.5
Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

Evidence Required:
3. The student relates the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

Tools: Calculator

Prompt Features: The student is prompted to select the correct statement describing the domain or range of a function modeling a contextual situation.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - The domain is indicated by the maximum and minimum values of a given graph or data table.
  - The domain is not indicated by the maximum and minimum values of a given graph or data table.
  - The domain is indicated by a description of the function.
  - The domain is represented by a set of coordinate pairs that the student has to calculate the domain value.

TM3b
Stimulus: The student is presented with a contextual situation, and asked to identify the domain of the function modeled by the given situation.

Example Stem: Billy buys light bulbs in packs of 8 for $20. The shipping cost is $10 regardless of the number of packs bought. Billy has only $120 to spend.

The cost per light bulb with respect to number of packs bought can be modeled by a function. Select the statement that correctly describes the domain of the function.

A. The domain is the set of all real numbers greater than or equal to 1 and less than or equal to 6.
B. The domain is the set of all real numbers greater than or equal to 0 and less than or equal to 5.
C. The domain is the set of all integers greater than or equal to 1 and less than or equal to 6.
D. The domain is the set of all integers greater than or equal to 0 and less than or equal to 5.

Rubric: (1 point) The student correctly selects the statement describing the domain or range of the function (e.g., D).

Response Types: Multiple Choice, single correct response

Task Model 3

Response Type: Multiple Choice, multiple correct response

DOK Level 2

F-IF.5
Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

Evidence Required:
3. The student relates the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

Tools: Calculator

Prompt Features: The student is prompted to select the correct statement describing the domain or range of a function modeling a contextual situation.

Stimulus Guidelines: (same as TM3b)

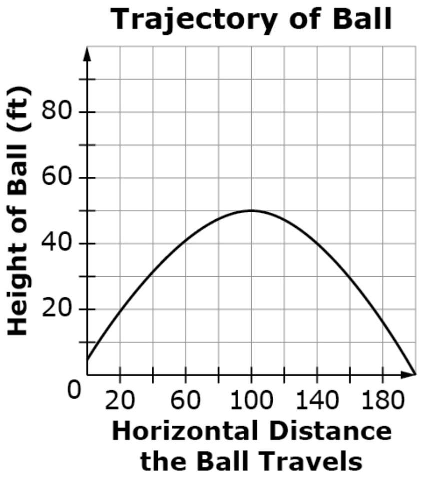
TM3c
Stimulus: The student is presented with a contextual situation, and asked to identify the domain of the function modeled by the given situation.

Example Stem 1: A farmer is selling watermelons. She has 43 watermelons and plans to sell them for $3 each. The farmer's total sales, in dollars, is a function of the number of watermelons she sells.

Select **all** the statements that correctly describe the domain or range of this function.

A. The domain is the set of all integers from 0 to 43.
B. The domain is the set of all real numbers from 0 to 43.
C. The range is the set of all integers between 0 and 129.
D. The range is the set of all multiples of 3 from 0 to 129.
E. The range is the set of all multiples of 43 from 43 to 129.

Example Stem 2: Sue hits a ball from a height of 4 feet. The height of the ball above the ground is a function of the horizontal distance the ball travels. Consider this graph of the function.



Select **all** values that are in the domain of the function as shown in the graph.

A. -5 feet
B. 0 feet
C. 60 feet
D. 220 feet

Rubric: (1 point) The student correctly selects the values that are within the domain (e.g., A, D; B, C).

Response Types: Multiple Choice, multiple correct response

Task Model 4

Response Type: Multiple Choice, single correct response

DOK Level 2

F-IF.6
Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Evidence Required:
4. The student calculates and interprets the average rate of change of a function presented symbolically or as a table and estimates the rate of change of a function from a graph.

Tools: Calculator

Prompt Features: The student is prompted to calculate the average rate of change of a given function over the specified interval, in terms of a context.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - The function is presented as a table.
  - The function is presented symbolically as a linear equation.
  - The function is presented symbolically as a quadratic or exponential equation.

TM4a
Stimulus: The student is presented with a function in symbolic form, representing a context familiar to 15- to 17-year-olds.

Example Stem: Craig records the number of minutes, *m*, it takes him to mow *n* lawns in a table.

n	1	2	3	4	5	6
m(*n*)	33	64	89	109	124	139

Select the average amount of time per lawn it takes Craig to mow the first 4 lawns. Round to the nearest minute per lawn.

A. 25 minutes per lawn
B. 27 minutes per lawn
C. 33 minutes per lawn
D. 74 minutes per lawn

Rubric: (1 point) The student identifies the correct value for the average rate of change (e.g., B).

Response Types: Multiple Choice, single correct response

Task Model 4

Response Type: Equation/Numeric

DOK Level 2

F-IF.6
Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Evidence Required:
4. The student calculates and interprets the average rate of change of a function presented symbolically or as a table and estimates the rate of change of a function from a graph.

Tools: Calculator

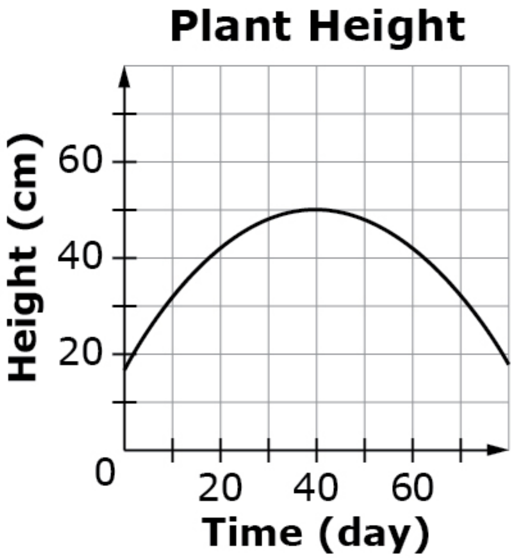
Prompt Features: The student is prompted to estimate the rate of change of a function from a graph.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
    - Representing a relationship modeled by a linear function
    - Representing a relationship modeled by a quadratic function, an exponential function (growth/decay), or a trigonometric function (periodic event)
    - Representing a relationship modeled by a function not capable of being represented as a linear, quadratic, exponential, or trigonometric function.

TM4b
Stimulus: The student is presented with a contextual situation, and the graph of the function modeled by the situation.

Example Stem: The height of a plant (in centimeters) is modeled as a function of time (in days). Consider this graph of the function.



Enter the average rate of change for the height of the plant, measured as centimeters per day, between day 0 and day 20.

Rubric:
(1 point) The student correctly enters the rate of change given a possible range of answers (e.g., 1.2 ± 0.1).

Response Type: Equation/Numeric

Task Model 4

Response Type: Equation/Numeric

DOK Level 2

F-IF.6
Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Evidence Required:
4. The student calculates and interprets the average rate of change of a function presented symbolically or as a table and estimates the rate of change of a function from a graph.

Tools: Calculator

Prompt Features: The student is prompted to calculate the average rate of change of a given function over the specified interval, in terms of a context.

Stimulus Guidelines:

- Item difficulty can be adjusted via these example methods, but is not limited to these methods:
  - The function is presented as a table.
  - The function is presented symbolically as a linear equation.
  - The function is presented symbolically as a quadratic or exponential equation.

TM4c
Stimulus: The student is presented with a nonlinear function in symbolic form.

Example Stem: During the first years of growth the height of a tree can be modeled with the function

$h = -t^2 + 12t + 10$,

where t is the time in years since being planted and h is the height in inches**.**

Enter the average rate of change, in inches per year, from year 1 to year 5.

Rubric:
(1 point) The student enters the correct answer for the average rate of change given the units (e.g., 6).

Response Type: Equation/Numeric

Task Model 1 **Response Type: Graphing** **DOK Level 2** **F-IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. **Evidence Required:** 1. Students graph functions expressed symbolically and show key features of the graph. **Tools:** None	**Prompt Features:** The student is prompted to graph a simple function and show key features. **Stimulus Guidelines:** • Graphs in answer choices must be within a -20 to 20 coordinate grid, unless otherwise specified. • Functions must be chosen so that Key Features fit on the grid. • Key Features are values that can be interchangeable on a per item basis, e.g., "Which of these is the *x*-intercept of the function?" • The Key Feature being tested must represent a whole number or a decimal to the tenths place: see Stimulus guidelines within task models. • Linear functions will: ○ be in the form of $f(x) = mx + b$ ○ $0 \leq m \leq 10$, $0 \leq x \leq 10$, and $0 \leq b \leq 10$ • Key Features for linear include: ○ slope ○ *x*-intercept ○ *y*-intercept • The quadratic function may take the following forms: a) $f(x) = ax^2 + bx + c$ b) $f(x) = a(x - h)^2 + k$ c) $f(x) = (dx + e)(fx + g)$ • Key Features for quadratic include: ○ *x*- intercepts and/or *y*-intercepts ○ increasing interval and/or decreasing interval ○ positive interval and/or negative interval ○ relative maximums and/or relative minimums ○ symmetries ○ end behavior ○ zeros • Square Roots functions will: ○ take the form $f(x) = a\sqrt{x - h} + k$ ○ *a* is 1 or -1 ○ *h* and *k* are single digit integers ○ *h* and *k* must be chosen so that there are *x*- and *y*-intercepts (e.g. not a function like $f(x) = \sqrt{x - 3} + 1$) • Cube Roots functions will: ○ have the form $f(x) = a\sqrt[3]{x - h} + k$ ○ *a* is 1 or -1 ○ *h* and *k* are single digit integers • Piecewise functions will: ○ have pieces that are linear, quadratic, square root, or absolute value • Absolute Value functions will: ○ have the form $f(x) = a\|x - h\| + k$ ○ *a* is rational ○ *h* and *k* are single digit integers • Key Features for square root, cube root, absolute value, and piecewise include: ○ *x*- intercepts and/or *y*-intercepts ○ increasing interval and/or decreasing interval

Task Model 1

Response Type:
Graphing

DOK Level 2

F-IF.7
Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Evidence Required:

1. Students graph functions expressed symbolically and show key features of the graph.

Tools: None

  - positive interval and/or negative interval
  - relative maximums and/or relative minimums
  - symmetries
  - end behavior
  - zeros
- Polynomials will:
  - have one variable only
  - have a minimum of two terms and maximum of five terms
  - be factorable
  - be given in the form of: $f(x) = ax^n + bx^{n-1} + \cdots + cx + d$, such that a, b, c, d must be integers greater than -5 and less than 5, and $0 \le n \le 4$, (i.e. maximum degree of 4)
- Key Features for polynomials include:
  - *x*- and *y*-intercepts (some polynomials will have only one *x*-intercept, e.g. $f(x) = x^3$-27)
  - zeroes (some polynomials will have only one zero, e.g. $f(x) = x^3$-27)
  - relative maximum and minimum values
  - end behavior
- Logarithmic functions:
  - must be in the form $f(x) = a\log(x \pm h) \pm k$ or $f(x) = aln(x \pm h) \pm k$
  - base 10 for log, or base *e for ln*
- Exponential functions:
  - must be in the form $f(x) = b^{x-h} \pm k$
  - where $1 < b \le 100$, *h* and *k* are single digit integers.
- Key Features include:
  - *x*- and *y*-intercepts
  - end behavior
- Functions must be chosen so that requested Key Features exist; for example, some exponential functions do not cross one of the axes, such as $f(x) = 3^{x-1} + 4$, and $f(x) = \log(x - 4) + 2$.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - Linear, quadratic, absolute value, square root, cube root, polynomials, piecewise, logarithmic, exponential.

TM1a
Stimulus: The student is presented with a function and a coordinate grid.

Example Stem 1: Given a linear function with a slope of $\frac{2}{3}$ and a *y*-intercept of 2:

- Using the Add Arrow tool, draw a line on the coordinate grid to graph the function.
- Place a point on the line representing the *x*-intercept of the function.

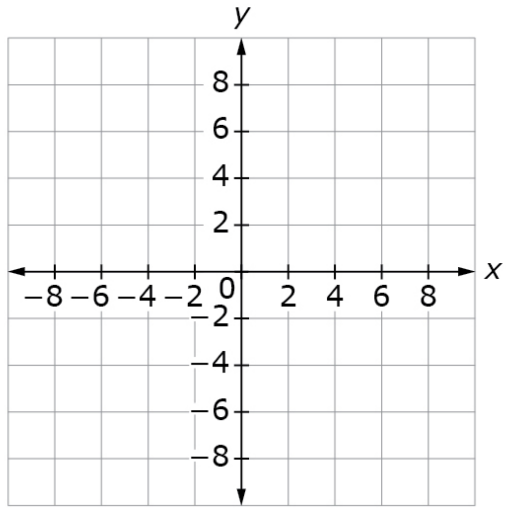
Example Stem 2: Given the function $y = \frac{2}{3}x + 2$,

- Using the Add Arrow tool, draw a line on the coordinate grid to graph the function.

- Place a point on the line representing the *x*-intercept of the function.

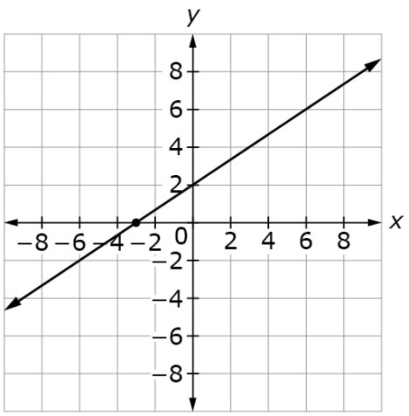
Example Stem 3: Given the function $y = \frac{1}{2}|2x - 1| + 2$,

- Use the Add Arrow tool to create a graph that represents the function.
- Place a point on the coordinate grid to show the *y*-intercept of the function.



Interaction: The student will graph lines using the Add Arrow tool and/or plot points using the Add Point tool.

Rubric: (2 points) The student graphs the correct line and plots the point at the correct location that represents a key feature [e.g., Example Stem 1, draws a correct line and plots the *x*-intercept located at (-3, 0)].
(1 point) The student graphs the correct line or plots the point at the correct location that represents a key feature (e.g., [e.g., Example Stem 1, draws a correct line OR plots the *x*-intercept located at (-3, 0)].



Response Type: Graphing

Task Model 1

Response Type: Graphing

DOK Level 2

F-IF.7
Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Evidence Required:

1. Students graph functions expressed symbolically and show key features of the graph.

Tools: Calculator

Prompt Features: The student is prompted to graph a complicated function, using the calculator tool, and show key features.

Stimulus Guidelines: (same as TM1a)

TM1b
Stimulus: The student is presented with a function and a coordinate grid.

Example Stem 1: Given the function $y = -x^2 + x + 6$,

- Place a point on the coordinate grid to show each *x*-intercept of the function.
- Place a point on the coordinate grid to show the maximum value of the function.

Example Stem 2: Given the function $y = \sqrt{x+4} - 1$,

- Place a point on the coordinate grid to show each *x*-intercept of the function
- Place a point on the coordinate grid to show the *y*-intercept of the function.

Example Stem 3: Given the function $y = \sqrt[3]{x-1} + 2$,

- Place a point on the coordinate grid to show the *x*-intercept of the function.
- Place a point on the coordinate grid to show the *y*-intercept of the function.

Example Stem 4: Given this piecewise-defined function:

$$y = \begin{cases} -2x + 5 & \text{for } x < -1 \\ 3x^2 + 4 & \text{for } -1 \leq x \leq 1 \\ -4x^2 + 11 & \text{for } x > 1 \end{cases}$$

- Place **four** points on the coordinate grid to show the values of *y* when *x* = -2, -1, 0, and 2.

Example Stem 5: Given the function $y = 4x^3 + 8x^2 - 21x$,

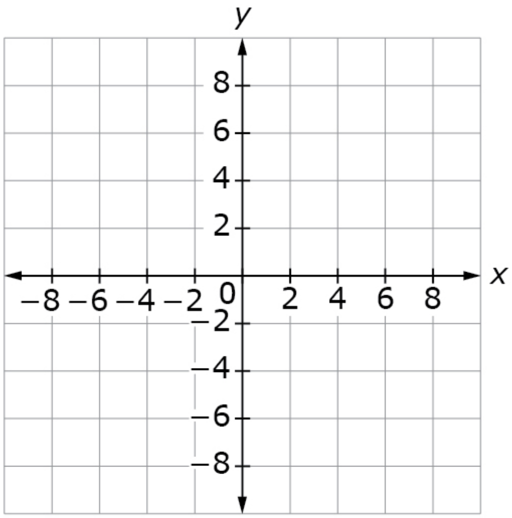
- Place a point on the coordinate grid to show each *x*-intercept of the function.
- Place a point on the coordinate grid to show each relative maximum or minimum value of the function.

Example Stem 6: Given the function $y = 3^{x-1} - 2$,

- Place a point on the coordinate grid to show each *x*-intercept of the function.
- Place a point on the coordinate grid to show each relative maximum or minimum value of the function.

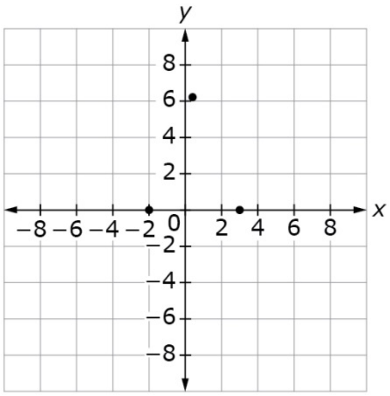
Example Stem 7: Given the function $y = 8\log(x + 4)$,

- Place a point on the coordinate grid to show the x-intercept of the function.
- Place a point on the coordinate grid to show the y-intercept of the function.



Interaction: The student will graph lines using the Add Arrow tool appropriate to the example stem (single or double) and/or plot points using the Add Point tool.

Rubric: (2 points) The student plots the correct points that represent each different key feature. (e.g., Example Stem 1, student plots both x-intercepts and the maximum value).
(1 point) The student correctly plots 1 of 2 key features called for OR creates a graph but incorrectly identifies a key feature (e.g., in Example Stem 1, student plots the maximum value only OR both x-intercepts only.)



Note: Both x-intercepts represent one key feature so both are required to earn a point. For example, in Example Stem 1 both x-intercepts represent one key feature (1 point), and the maximum point represents another key feature (1 point).

Response Type: Graphing

Task Model 2

Response Type: Equation/Numeric

DOK Level 2

F-IF.8a

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function:

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

Evidence Required:

2. Students write a quadratic function defined by an expression in equivalent factored form and completing the square form to reveal zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

Tools: None

Prompt Features: Students are prompted to rewrite a quadratic to reveal the key features of its graph.

Stimulus Guidelines: The student is presented with a quadratic function used in a context. The quadratic function is:

- given in the form of $ax^2 + bx + c$,
- or in factored form, which is $a(x - h)(x - k)$,
- or in completed square form, which is $a(x - h)^2 + k$, where $h = -b/2a$ and $k = c - b^2/4a$
- a, b, and c may be are numbers with an absolute value less than 20.

TM2a

Stimulus: The student is presented with a quadratic function.

Example Stem:

Enter an equation for the line of symmetry for the function $f(x) = -8x^2 + 16x + 2$.

Rubric:

(1 point) The student enters the correct equation (e.g., $x = 1$).

Response Type: Equation/Numeric

Task Model 2

Response Type: Equation/Numeric

DOK Level 2

F-IF.8a
Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function:

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

Evidence Required:
2. Students write a quadratic function defined by an expression in equivalent factored form and completing the square form to reveal zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

Tools: None

Prompt Features: The student is prompted to rewrite a quadratic to reveal the key features of its graph, in terms of a context: the zeros, the maximum/minimum value, various points in terms of the line of symmetry, or intervals where the function is increasing/decreasing. Context can include, but is not limited to, an object being hit/thrown, profit, maximum area, and cost.

Stimulus Guidelines: The student is presented with a quadratic function used in a context. The quadratic function is:

- given in the form of $ax^2 + bx + c$,
- or in factored form, which is $a(x-h)(x-k)$,
- or in completed square form, which is $a(x-h)^2 + k$, where $h = -b/2a$ and $k = c - b^2/4a$
- a, b, and c may be are numbers with an absolute value less than 20.

TM2b
Stimulus: The student is presented with a quadratic function used in a context.

Example Stem 1:
John launches a toy rocket into the air. The rocket's height (*d)* in feet with respect to time (*t*) in seconds, can be modeled by the quadratic function, $d = -16t^2 + 16t + 32$**.**

Enter the maximum height, in feet, of the rocket.

Example Stem 2:
John launches a toy rocket into the air. The rocket's height (*d)* in feet with respect to time (*t*) in seconds, can be modeled by the quadratic function, $d = -16t^2 + 16t + 32$**.**

Enter the number of seconds it took for the rocket to hit the ground after it was launched.

Rubric:
(1 point) The student enters the correct value (e.g., 36; 2).

Response Type: Equation/Numeric

Task Model 3

Response Type: Matching Tables

DOK Level 1

F-IF.8b

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function:

> b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions, such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*

Evidence Required:

3. Students write an exponential function defined by an expression in an equivalent form using the properties of exponents to reveal and explain different properties of the function and to classify them as representing exponential growth or decay.

Tools: None

Prompt Features: The student will use the properties of exponents to interpret expressions for exponential functions.

Stimulus Guidelines:

- Exponential functions will:
  - be given in the form of $f(x) = ab^{(x-h)} + k$
  - h is a single digit integer
  - k is an integer, maximum value of 19
  - a = 1 or -1
  - b is a rational number, maximum value of 9; can be a non-repeating decimal.
- Key Features are values that can be interchangeable on a per item basis, e.g., "Which of these is the growth rate of the exponential function?"
- Key Features include:
  - end behavior
  - rates of growth or decay
- The Key Feature being tested must represent a whole number or a decimal to the tenths place: see Stimulus guidelines within task models.
- Item difficulty can be adjusted to these example methods, but are not limited to these methods:
  - Interpreting growth vs. decay
  - Rewriting exponentials

TM3

Stimulus: The student is presented with multiple functions.

Example Stem: Determine whether each function represents exponential growth or decay. Select the correct option for each function.

Function	Growth	Decay
$f(x) = (1/2)^x$		
$f(x) = (3/2)^{4x}$		
$f(x) = (7/8)^{4x}$		
$f(x) = (4/3)^{\frac{x}{12}}$		
$f(x) = 3(1/3)^{\frac{x}{12}}$		

Rubric:

(1 point) The student correctly sorts the exponential functions (e.g., Decay, Growth, Decay, Growth, Decay).

Response Type: Matching Tables

Task Model 4

Response Type:
Matching Tables

DOK Level 2

F-IF.9
Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*

Evidence Required:
4. Students compare properties of two functions represented in different ways (e.g., as equations, tables, graphs, or written descriptions).

Tools: Calculator

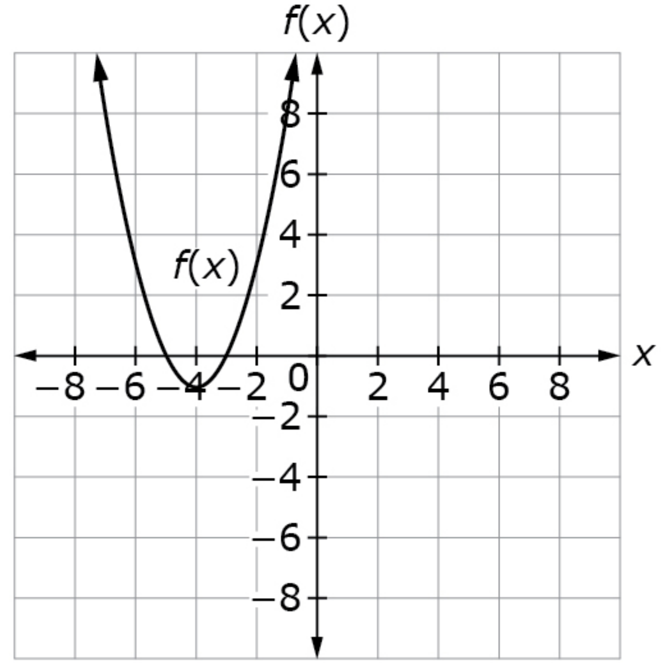
Prompt Features: Students will identify the relationships, common properties, or key features shared between two functions represented in different ways.

Stimulus Guidelines:

- Functions include: linear, quadratic, square root, cube root, piecewise-defined, absolute value, polynomial, exponential, and logarithmic functions.
- Key Features are values that can be interchangeable on a per item basis, e.g., "Which of these two functions has the higher relative maximum?"
- Key Features include:
    - maximum and minimum values (for quadratic, piecewise-defined, absolute value, and polynomial functions)
    - end behavior (for square root and logarithmic functions: positive *x*-direction only)
    - *x*-intercepts and y-intercepts (for *x*-intercepts, not exponential; for *y*-intercepts, not logarithmic)
    - increasing and decreasing intervals
    - lines of symmetry
    - zeros
- The Key Feature being tested must represent a whole number or a decimal to the tenths place: see Stimulus guidelines within task models.
- Item difficulty can be adjusted to these example methods, but are not limited to these methods:
    - Functions come in table, graph or written description form.

TM4a
Stimulus: The student is presented with two functions that must be represented in two different ways. Functions can be represented as a table of values, a graph, a function equation, or a written description.

Example Stem: The graph represents $f(x)$ and the table shows some values of another quadratic function $g(x)$.



x	−4	−3	−2	−1	0	1	2	3	4	5	6
g(x)	0	−9	−16	−21	−24	−25	−24	−21	−16	−9	0

Select whether each statement is **True** or **False** about the given functions.

Statement	True	False
The minimum x value of $f(x)$ is greater than the minimum x value of $g(x)$.		
The value of x when $f(x)$ is at its minimum is less than the value of x when $g(x)$ is at its minimum.		
Both x intercepts of $g(x)$ occur when x is greater than zero.		
The line of symmetry of $f(x)$ is $x = 1$.		

Rubric:
(1 point) The student correctly identifies each statement as True or False (e.g., TTFF).

Response Type: Matching Tables

Task Model 4

Response Type:
Hot Spot

DOK Level 2

F-IF.9
Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*

Evidence Required:
4. Students compare properties of two functions represented in different ways (e.g., as equations, tables, graphs, or written descriptions).

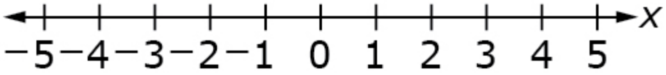
Tools: Calculator

Prompt Features: Students will select sections on a number line that represent an interval where two graphs have a shared key feature.

Stimulus Guidelines: (same as TM4a)

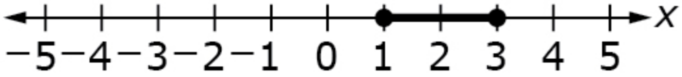
TM4b
Stimulus: The student is given two different functions (square root, cube root, piecewise-defined, or absolute value) and a number line representing the *x*-axis, and asked to indicate where the functions have a shared key feature.

Example Stem: In which interval(s) on the *x*-axis are the functions $f(x) = \frac{1}{2}|2x| + 2$ and $g(x) = -2x^2 + 12x - 16$ increasing? Click the interval(s) on the number line that represents where **both** functions are increasing.



Interaction: The student will click on intervals on the number line using Hot Spots.

Rubric:
(1 point) The student clicks on the correct intervals (e.g., [1, 3]).



Response Type: Hot Spot

Task Model 4

Response Type:
Matching Tables

DOK Level 2

F-IF.9
Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*

Evidence Required:
4. Students compare properties of two functions represented in different ways (e.g., as equations, tables, graphs, or written descriptions).

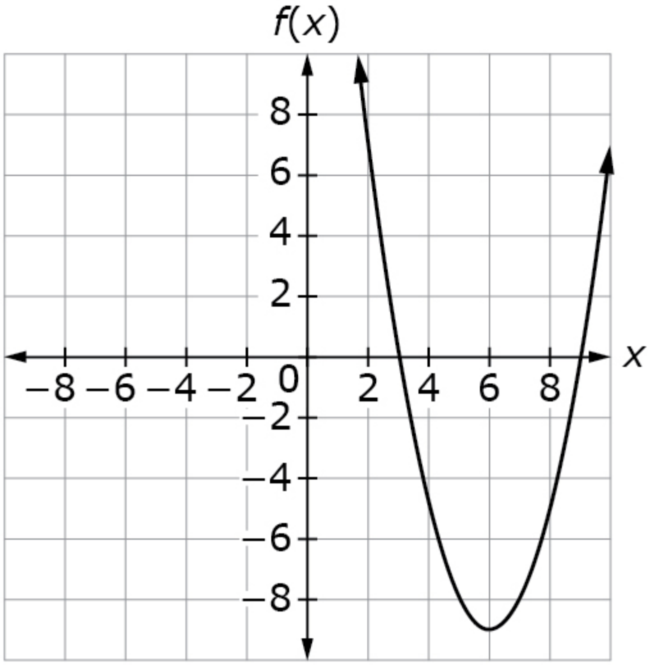
Tools: None

Prompt Features: Students will identify the relationships, common properties, or key features shared between two functions represented in different ways.

Stimulus Guidelines: (same as TM4a)

TM4c
Stimulus: The student is presented with the graph of a quadratic function and a table of equations that may or may not represent the function.

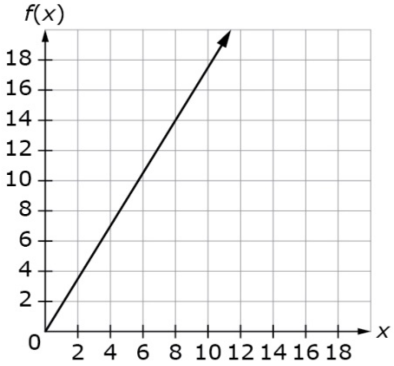
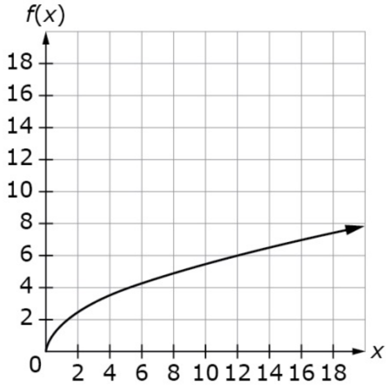
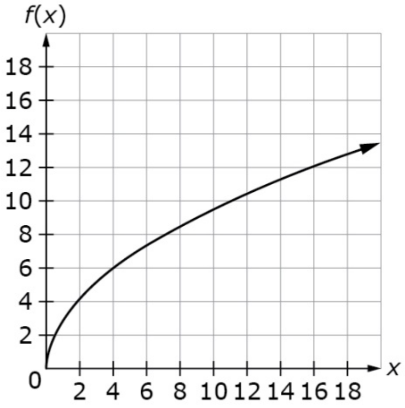
Example Stem: Determine whether each equation in the table represents the graph of the function shown? Select Yes or No for each equation.



Function	Yes	No
$f(x) = (x-3)(x-9\ )$		
$f(x) = (x+3)(x-9)$		
$f(x) = (x+6)(x-9)$		
$f(x) = (x-3)^2 - 18$		
$f(x) = (x-6)^2 - 9$		

Rubric:
(1 point) Student correctly selects the functions that could be represented by the given graph (e.g., YNNNY).

Response Type: Matching Tables

	TM4d **Stimulus:** The student is presented with three functions in various forms (graphs, table of values, etc.) and a matching table that includes the equations of the three functions. **Note:** If tables are given, the ordered pairs should show key features (zeros, etc.). **Example Stem 1:** Select the appropriate box to indicate the match of each graph to its equation. **Graph A**  **Graph B**  **Graph C** 

Equation	Graph A	Graph B	Graph C
$f(x) = x\sqrt{3}$			
$f(x) = 3\sqrt{x}$			
$f(x) = \sqrt{3x}$			

Rubric:
(1 point) The student correctly matches the functions with the graph (e.g., Table A, Table C, Table B).

Example Stem 2: Select the appropriate box to indicate the match of each table of values to its equation.

Table A

x	*f*(*x*)
1	1.73
2	3.46
4	6.92
6	10.38
8	13.84

Table B

x	*f*(*x*)
1	1.73
2	2.45
4	3.46
6	4.24
8	4.90

Table C

x	*f*(*x*)
1	3.00
2	4.24
4	6.00
6	7.35
8	8.49

Equation	Table A	Table B	Table C
$f(x) = x\sqrt{3}$			
$f(x) = 3\sqrt{x}$			
$f(x) = \sqrt{3x}$			

Rubric:
(1 point) The student correctly matches the functions with the table (e.g., Table A, Table C, Table B).

Response Type: Matching Tables

Task Model 1 **Response Type: Equation/Numeric** **DOK Level 2** **F-BF.1** Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. **Evidence Required:** 1. The student writes explicit or recursive functions to describe relationships between two quantities from a context. **Tools:** Calculator	**Prompt Features:** The student is prompted to enter a function that describes a relationship between two quantities by determining an explicit function from context. **Stimulus Guidelines:** The student is presented with a contextual situation that describes a relationship between two quantities that can be modeled by a function. - Functions can include linear, quadratic, or exponential. - Difficulty level can be altered by varying the type of function and context. **TM1a** **Stimulus:** Student is presented with a contextual situation. **Example Stem 1:** Jane is making a rectangular garden. The length of the garden is 2 yards greater than its width, *w*, in yards. Enter the function, *f*(*w*), which describes the area, in square yards, of Maria's garden as a function of the width, *w*. **Example Stem 2:** Barb traveled 300 miles during the first 5 hours of her trip. Barb then traveled at a constant speed of 50 miles per hour for the remainder of the trip. Enter the function, *f(h),* which describes the average speed during the entire trip as a function of time, *h,* in hours, Barb traveled after her first 300 miles. **Example Stem 3:** A washing machine was purchased for $256. It loses $\frac{1}{4}$ of its value each year. Enter the function, *f*(*t*), which describes the value of the washing machine, in dollars, as a function of time in years, *t*, after the initial purchase. **Rubric:** (1 point) Student correctly enters the function describing the relationship between two quantities in the given contextual situation (e.g., $f(w) = w(w+2)$; $f(h) = \frac{300+50h}{5+h}$; $f(t) = \$256(0.75)^{t}$). **Response Type:** Equation/Numeric

Task Model 1

Response Type: Equation/Numeric

DOK Level 2

F-BF.1
Write a function that describes a relationship between two quantities.
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Evidence Required:
1. The student writes explicit or recursive functions to describe relationships between two quantities from a context.

Tools: Calculator

Prompt Features: The student is prompted to enter a function that describes a relationship between two quantities by determining a recursive process from context.

Stimulus Guidelines: The student is presented with a contextual situation that describes a relationship between two quantities that can be modeled by a function.

- Function types can include linear, quadratic, or exponential.
- Difficulty level can be altered by varying the type of function and context.

TM1b
Stimulus: The student is presented with a contextual situation.

Example Stem 1: A researcher studies the growth of a fruit fly population. The researcher counts the number of fruit flies at noon each day. The results are in the table.

Day	Number of Fruit Flies
0	4
1	8
2	16
3	32

- $V(t)$= Total number of fruit flies after *t* days
- $V(0) = 4$

Enter the function for $t \geq 1$, which describes the number of fruit flies, $V(t)$, at noon on the t^{th} day in terms of the number of fruit flies at noon on the previous day, $V(t-1)$.

Example Stem 2: The height of the water level in a tank is 200 inches. The water level increases at a constant rate of 3 inches every day.

- $H(t)$= height of the water level after t days.
- $H(0) = 200$

Enter the function for $t \geq 1$ that describes the height of the water level, $H(t)$, on the t^{th} day in terms of the height of the water level at the same time on the previous day, $H(t-1)$.

Rubric: (1 point) Student correctly enters the recursive function describing the relationship between two quantities in the given contextual situation [e.g., $V(t) = 2V(t-1)$; $H(t) = H(t-1) + 3$)].

Response Type: Equation/Numeric

Task Model 1

Response Type: Equation/Numeric

DOK Level 2

F-BF.1
Write a function that describes a relationship between two quantities.
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Evidence Required:
1. The student writes explicit or recursive functions to describe relationships between two quantities from a context.

Tools: Calculator

Prompt Features: The student is prompted to model a given contextual situation as a sequence using a recursive function or an explicit formula. The sequence position of data is known.

Stimulus Guidelines: The student is presented with a contextual description of two quantities.

- The context can be modeled by:
    - an arithmetic sequence
    - a geometric sequence
- Difficulty level can be altered by varying the complexity of function and context.

TM1c
Stimulus: The student is presented with a contextual situation.

Example Stem 1: The first row in a theater has 8 seats, the second row has 11 seats, the third row has 14 seats and the fourth row has 17 seats.

- $f(r)$ = the number of seats in row r.
- $f(1) = 8$

Enter an equation, for $r \geq 2$, which describes the number of seats, $f(r)$, in the r^{th} row in terms of the number of seats in the $(r - 1)^{\text{th}}$ row, $f(r - 1)$. Assume that the pattern described applies to all rows.

Example Stem 2: The 13th row in a theater has 41 seats, the 12th row has 38 seats, the 11th row has 35 seats and the 10th row has 32 seats.

- $f(r)$ = the number of seats in row r.
- $f(1) = 5$

Enter an equation, for $r \geq 2$, which describes the number of seats, $f(r)$, in the r^{th} row in terms of the number of seats in the $(r-1)^{\text{th}}$ row, $f(r-1)$. Assume that the pattern described applies to all rows.

Rubric: (1 point) Student correctly represents the sequence using the recursive process [e.g., $f(r) = f(r-1) + 3$; $f(r) = f(r-1) + 3$].

Response Type: Equation/Numeric

Task Model 2

Response Type:

Multiple Choice, single correct response

DOK Level 2

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

Evidence Required:
2. The student translates between recursive functions and explicit functions.

Tools: Calculator

Prompt Features: The student is prompted to select a recursive or explicit function that is equivalent to a given function.

Stimulus Guidelines:

- Sequences can be either arithmetic or geometric in a given item.
- Domain should only include integers, excluding rational numbers.
- a_1 needs to be less than or equal to ±20.
- Difference between numbers in arithmetic sequence should be less than or equal to five.
- Difficulty level can be altered by varying the type of function and context.

TM2a
Stimulus: The student is presented with an explicit or recursive function.

Example Stem 1: Consider this function in explicit form.

$$f(n) = 3n - 4; n \geq 1$$

Select the equivalent recursive function.

A. $$\begin{gathered} f(1) = -1 \\ f(n) = f(n-1) + 3;\ n \geq 2 \end{gathered}$$

B. $$\begin{gathered} f(1) = -1 \\ f(n) = 3f(n-1);\ n \geq 2 \end{gathered}$$

C. $$\begin{gathered} f(0) = -4 \\ f(n) = 3f(n-1);\ n \geq 2 \end{gathered}$$

D. $$\begin{gathered} f(0) = -4 \\ f(n) = f(n-1) + 3;\ n \geq 2 \end{gathered}$$

Example Stem 2: Consider this function in recursive form.

$$\begin{gathered} f(1) = -3 \\ f(n) = 3f(n-1);\ n \geq 2 \end{gathered}$$

Select the equivalent explicit function for $n \geq 1$.

A. $f(n) = -3(n)$
B. $f(n) = -3(n-1)$
C. $f(n) = -3(3)^n$
D. $f(n) = -3(3)^{(n-1)}$

Rubric: (1 Point) Student selects the correct choice (e.g., A; D).

Response Type: Multiple Choice, single correct response

Task Model 2

Response Type:
Matching tables

DOK Level 2

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

Evidence Required:
2. The student translates between recursive functions and explicit functions.

Tools: Calculator

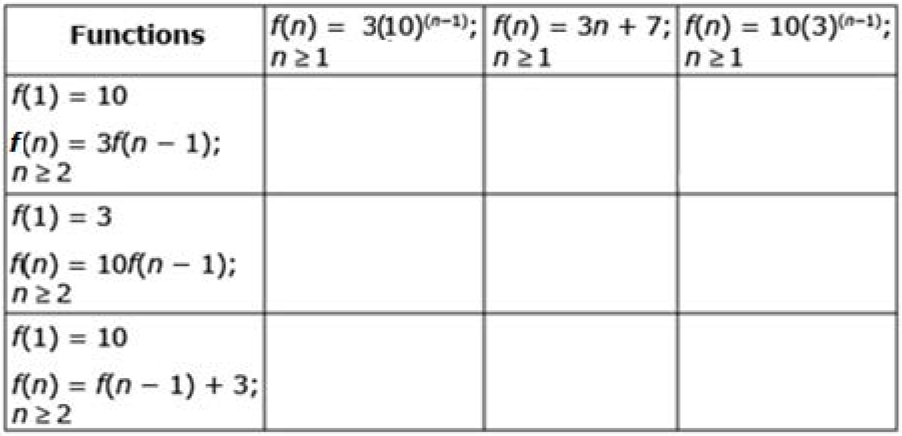
Prompt Features: The student is prompted to match explicit functions with their equivalent recursive functions.

Stimulus Guidelines:

- All explicit functions will have an equivalent recursive function.
- Sequences can be either arithmetic or geometric in a given item.
- Domain should only include integers, excluding rational numbers.
- a_1 needs to be less than or equal to ±20.
- Difference between numbers in arithmetic sequence should be less than or equal to five.
- Difficulty level can be altered by varying the type and complexity of function.

TM2b
Stimulus: The student is presented with explicit and recursive functions.

Example Stem: Match each recursive function with the equivalent explicit function.

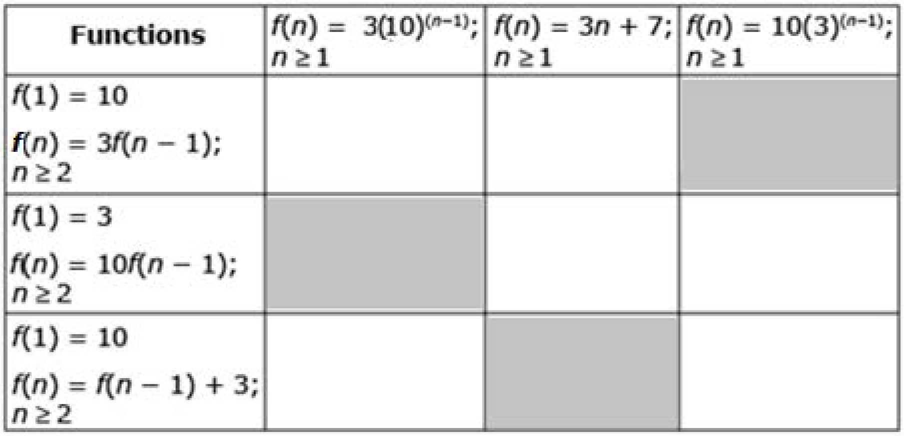


Functions	$f(n) = 3(10)^{(n-1)}$; $n \geq 1$	$f(n) = 3n + 7$; $n \geq 1$	$f(n) = 10(3)^{(n-1)}$; $n \geq 1$
$f(1) = 10$ $f(n) = 3f(n-1)$; $n \geq 2$			
$f(1) = 3$ $f(n) = 10f(n-1)$; $n \geq 2$			
$f(1) = 10$ $f(n) = f(n-1) + 3$; $n \geq 2$			

Click the appropriate box that matches the recursive function in the first column with its explicit function in the top row.

Interaction: The student is presented with three explicit functions in the first row and three recursive functions in the first column. The student selects the cell in the table that matches the functions.

Rubric:
(1 point) Student correctly matches all functions.



Functions	$f(n) = 3(10)^{(n-1)}$; $n \ge 1$	$f(n) = 3n + 7$; $n \ge 1$	$f(n) = 10(3)^{(n-1)}$; $n \ge 1$
$f(1) = 10$ $f(n) = 3f(n-1)$; $n \ge 2$			▨
$f(1) = 3$ $f(n) = 10f(n-1)$; $n \ge 2$	▨		
$f(1) = 10$ $f(n) = f(n-1) + 3$; $n \ge 2$		▨	

Response Type: Matching tables

Task Model 3

Response Type:
Multiple Choice, single correct response

DOK Level 2

F-BF.1 Write a function that describes a relationship between two quantities.

Evidence Required:
3. The student understands a function as a model of the relationship between two quantities.

Tools: Calculator

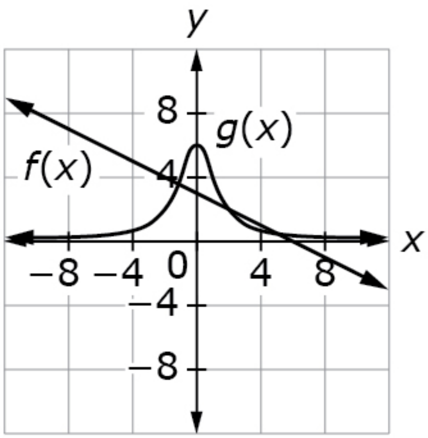
Prompt Features: The student is prompted to select the graph that represents the relationship of two given functions.

Stimulus Guidelines:

- The scale of the graphs presented in the answer choices must coincide with the scale of the graph in the stem.
- Difficulty level can be altered by varying the type of functions.

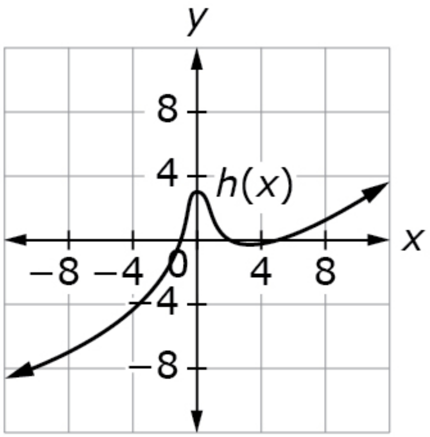
TM3a
Stimulus: The student is presented with a graph of two functions.

Example Stem: Consider this graph.

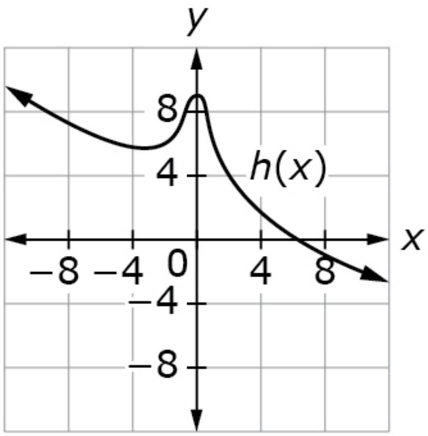


Using the graphs shown, select the graph that represents *h*(*x*), where function *h*(*x*) = *f*(*x*) + *g*(*x*).

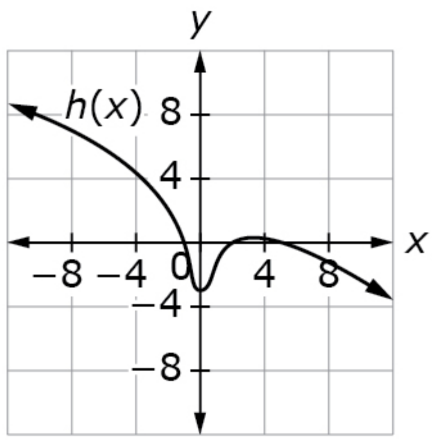
A.



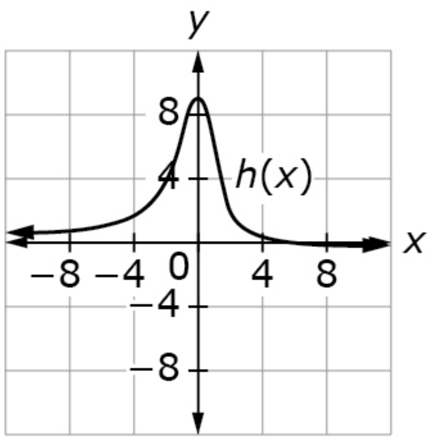
B.



C.



D.



Rubric: (1 point) Student selects the correct graph for *h(x)* (e.g., B).

Response Type: Multiple Choice, single correct response

Source: Adapted from Illustrative Mathematics.

Task Model 3 **Response Type:** **Fill-in table** **DOK Level 2** **F-BF.1** Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. **Evidence Required:** 3. The student understands a function as a model of the relationship between two quantities. **Tools:** Calculator	**Prompt Features:** The student is prompted to model a given contextual situation as a sequence using a recursive function. **Stimulus Guidelines:** • The student is presented with a contextual description of two quantities that can be modeled by: ○ an arithmetic sequence ○ a geometric sequence • The sequence position of data is known. • Difficulty level can be altered by varying the type of function and context. **TM3b** **Stimulus:** The student is presented with a contextual situation. **Example Stem:** A theater needs to place seats in rows. The function, *f*(*r*), as shown below, can be used to determine the number of seats in each row, where *r* is the row number. $f(1) = 8$ $f(r) = f(r-1) + 3$ Use the function to complete the table indicating the number of seats in each of the first four rows of the theater. **Row number** | **Number of Seats** Row 1 | Row 2 | Row 3 | Row 4 | **Rubric:** (1 point) Student correctly enters the sequence from the recursive form into the table. **Row number** | **Number of Seats** Row 1 | 8 Row 2 | 11 Row 3 | 14 Row 4 | 17 **Response Type:** Fill-in table

Task Model 1

Response Type: Multiple Choice, single correct response

DOK Level 1

G-SRT.6
Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

Evidence Required:
1. Student uses the definitions of trigonometric ratios for acute angles in a right triangle.

Tools: None

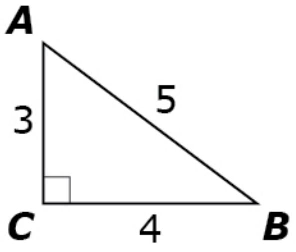
Prompt Features: The student is prompted to identify a trigonometric ratio (sine, cosine, or tangent) for the given angle.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by requiring basic definitions of the trigonometric ratios or by applying the trigonometric ratios to find lengths of sides of a right triangle, etc.

TM1a
Stimulus: The student is presented with a right triangle that has given side lengths.

Example Stem: Consider this right triangle.



Select the ratio equivalent to $\sin(B)$.

A) $\frac{4}{5}$

B) $\frac{5}{3}$

C) $\frac{3}{5}$

D) $\frac{3}{4}$

Rubric: (1 Point) The student selects the correct ratio (e.g., C).

Response Type: Multiple Choice, single correct response

Task Model 1

Response Type: Matching Tables

DOK Level 1

G-SRT.6
Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

Evidence Required:
1. Student uses the definitions of trigonometric ratios for acute angles in a right triangle.

Tools: None

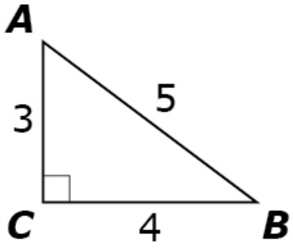
Prompt Features: The student is prompted to identify a trigonometric ratio (sine, cosine, or tangent) for the given angle.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by requiring basic definitions of the trigonometric rations, or by applying the trigonometric ratios to find lengths of sides of a right triangle, etc.

TM1b
Stimulus: The student is presented with a right triangle that has given side lengths.

Example Stem: Consider this right triangle.

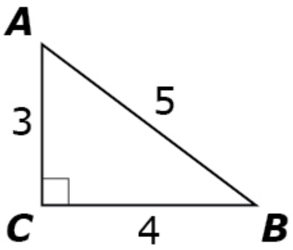


Determine whether each equation is correct. Select Yes or No for each equation.

	Yes	No
$\sin(A) = \frac{4}{5}$		
$\cos(A) = \frac{5}{3}$		
$\sin(B) = \frac{3}{5}$		
$\cos(B) = \frac{3}{4}$		

Rubric: (1 Point) The student chooses the correct option for each equation (e.g., YNYN).

Response Type: Matching Tables

Task Model 1 **Response Type: Equation/Numeric** **DOK Level 1** **G-SRT.6** Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles. **Evidence Required:** 1. Student uses the definitions of trigonometric ratios for acute angles in a right triangle. **Tools:** None	**Prompt Features:** The student is prompted to identify a trigonometric ratio (sine, cosine, or tangent) for the given angle. **Stimulus Guidelines:** • Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles. • Right triangles have measures for sides or angles. • Right triangles may have unknown sides or angles that can be solved using trigonometric ratios. • Side lengths should be limited to less than 40. • Side lengths may be whole numbers or simple expressions. • Difficulty level can be altered by requiring basic definitions of the trigonometric ratios, or by applying the trigonometric ratios to find lengths of sides of a right triangle, etc. **TM1c** **Stimulus:** The student is presented with a right triangle that has given side lengths. **Example Stem:** Consider this right triangle.  Enter the ratio equivalent to sin(B). **Rubric:** (1 Point) The student enters the correct value (e.g., $\frac{3}{5}$).

Task Model 2

Response Type: Multiple Choice, multiple correct choice

DOK Level 1

G-SRT.6
Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

Evidence Required:
2. Student uses similar triangles to define and determine trigonometric ratios in right triangles.

Tools: Calculator

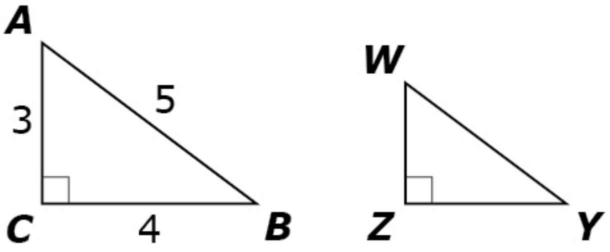
Prompt Features: The student is prompted to identify which angle or angles in each triangle satisfy a given trigonometric ratio.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown side lengths that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by asking students to compare trigonometric ratios of similar right triangles, comparing right triangles with different orientation, etc.

TM2
Stimulus: The student is presented with two right triangles that are similar and asked to identify the angle or angles that satisfy a trigonometric ratio.

Example Stem: Triangle ABC is similar to triangle WYZ.



Select all angles whose tangent equals $\frac{3}{4}$.

A) $\angle A$
B) $\angle B$
C) $\angle C$
D) $\angle W$
E) $\angle Y$
F) $\angle Z$

Rubric: (1 point) The student correctly identifies all angles (e.g., B, E).

Response Type: Multiple Choice, multiple correct response

Task Model 3 **Response Type: Equation/Numeric** **DOK Level 1** **G-SRT.7** Explain and use the relationship between the sine and cosine of complementary angles. **Evidence Required:** 3. Student explains and uses the relationship between the sine and cosine of complementary angles. **Tools:** Calculator	**Prompt Features:** The student is prompted to write the angle measure that will satisfy an equation. **Stimulus Guidelines:** • Stimuli may include sine or cosine of a specified angle less than 90 degrees and its value. • Sine or cosine of a missing angle with the same value as the given angle. • Difficulty level can be altered by asking students to write the angle measure of complementary angles when comparing the sine and cosine value, compare the sine and cosine values of various angle measures, etc. **TM3** **Stimulus:** The student is given the value (as a fraction or a decimal) of the sine or cosine for a specified angle and asked to fill in the blank for an equation involving the sine or cosine of the complement with the same value. **Example Stem 1:** Let, $\sin(47°) = 0.7314$. Enter the angle measure (β), in degrees, for $\cos(\beta) = 0.7314$. **Example Stem 2:** Let, $\sin(30°) = \frac{1}{2}$. Enter the angle measure (β), in degrees, for $\cos(\beta) = \frac{1}{2}$. **Rubric**: (1 point) The student enters the correct angle that can be used to satisfy the equation. Example Stem 1: any value so that 360*n*+43 where *n* is an integers. Example Stem 2: any value so that 60(6*n*+1) where *n* is an integer. **Response Type:** Equation/Numeric

Task Model 4

Response Type:
Matching Tables

DOK Level 2

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

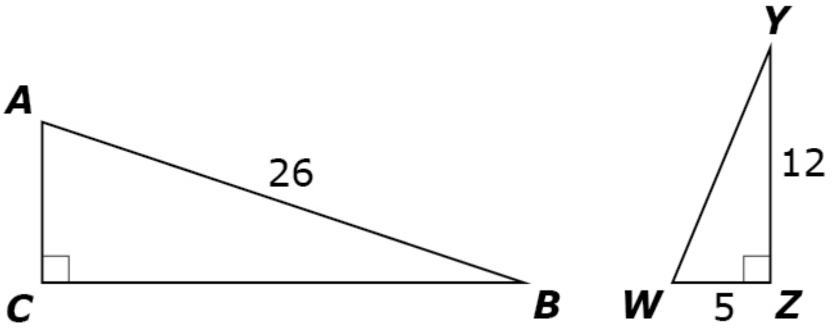
Prompt Features: The student is prompted to identify true or false statements about two similar triangles. The lengths of two sides of one triangle and one side of the second triangle are labeled.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by asking students to find the side or angle that can be found using a trigonometric expression, use knowledge of trigonometric ratios and Pythagorean Theorem to find a missing side length or angle measure in a right triangle, to solve for an angle measure or distance, given a verbal description of a situation where trigonometric ratios can be used, etc.

TM4a
Stimulus: The student is presented with two similar triangles. The lengths of two sides of one triangle and one side of the second triangle are labeled.

Example Stem: Triangle ABC is similar to triangle WYZ.



Determine whether each statement is true. Select True or False for each statement.

	True	False
sin(A) < sin(Y)		
cos(B) = sin(W)		
tan(W) > tan(A)		

Rubric: (1 point) The student evaluates each statement correctly (e.g., FTF).

Response Type: Matching Tables

Task Model 4

Response Type:
Matching Table

DOK Level 1

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

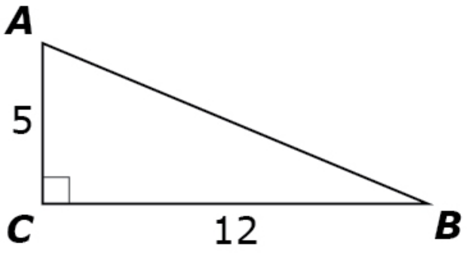
Prompt Features: The student is prompted to determine trigonometric functions that can be used to find a side length of a right triangle.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by asking students to find the side or angle that can be found using a trigonometric expression, use knowledge of trigonometric ratios and Pythagorean Theorem to find a missing side length or angle measure in a right triangle, to solve for an angle measure or distance, given a verbal description of a situation where trigonometric ratios can be used, etc.

TM4b
Stimulus: The student is presented with a right triangle and two side lengths or a side and an angle measure and asked to write the trigonometric equation used to solve for a side or angle.

Example Stem: Consider this right triangle.



Determine whether each expression can be used to find the length of $\overline{AC}$. Select Yes or No for each expression.

	Yes	No
$13\sin(B)$		
$13\cos(A)$		
$12\tan(A)$		
$12\tan(B)$		

Rubric:
(1 point) The student selects the correct response for each expression (e.g., YYNY).

Response Type: Matching Tables

Task Model 4

Response Type:
Equation/Numeric

DOK Level 2

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

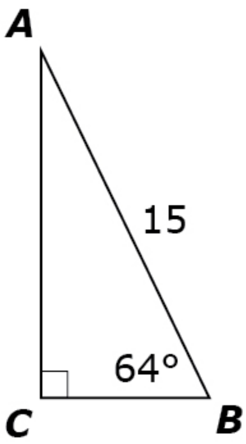
Prompt Features: The student is prompted to solve for a missing side in a right triangle using trigonometric ratios.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by asking students to find the side or angle that can be found using a trigonometric expression, use knowledge of trigonometric ratios and Pythagorean Theorem to find a missing side length or angle measure in a right triangle, to solve for an angle measure or distance, given a verbal description of a situation where trigonometric ratios can be used, etc.

TM4c
Stimulus: The student is presented with a right triangle and asked to find a missing side using information given in the problem.

Example Stem: Consider this right triangle.



Enter the length of $\overline{AC}$, to the nearest tenth.

Rubric:
(1 point) The student enters the correct side length (e.g., 13.5).

Response Type: Equation/Numeric

Task Model 4

Response Type:
Equation/Numeric

DOK Level 2

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

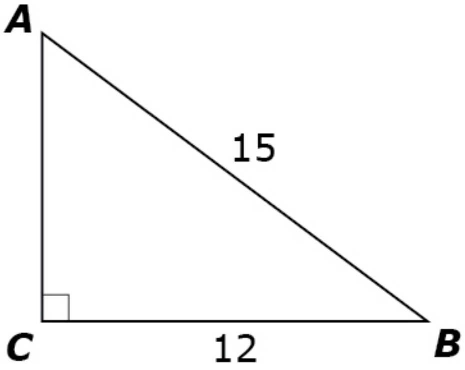
Prompt Features: The student is prompted to solve for a missing angle in a right triangle using trigonometric ratios.

Stimulus Guidelines:

- Stimuli may include right triangles or descriptions of the features (angles, side lengths, sine, cosine, or tangent values) of triangles.
- Right triangles have measures for sides or angles.
- Right triangles may have unknown sides or angles that can be solved using trigonometric ratios.
- Side lengths should be limited to less than 40.
- Side lengths may be whole numbers or simple expressions.
- Difficulty level can be altered by asking students to find the side or angle that can be found using a trigonometric expression, use knowledge of trigonometric ratios and Pythagorean Theorem to find a missing side length or angle measure in a right triangle, to solve for an angle measure or distance, given a verbal description of a situation where trigonometric ratios can be used, etc.

TM4d
Stimulus: The student is presented with a right triangle and asked to find a missing angle using information given in the problem.

Example Stem: Consider this right triangle.



Enter the measure of ∠A, to the nearest degree.

Rubric:
(1 point) The student enters the correct angle measure (e.g., 53).

Response Type: Equation/Numeric

Task Model 4

Response Type: Multiple Choice, multiple correct response

DOK Level 1

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

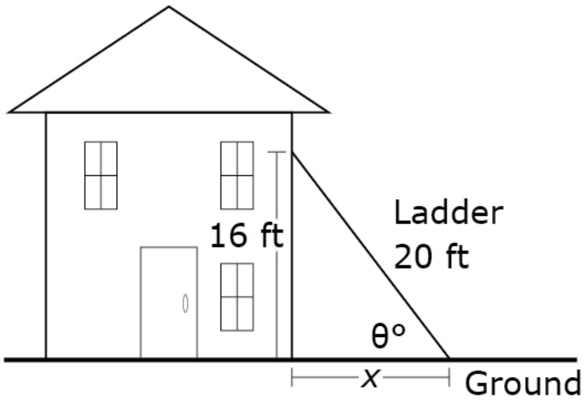
Prompt Features: The student is prompted to identify the equation for a missing angle in a right triangle given real-world context by using the Pythagorean Theorem and trigonometric ratios.

Stimulus Guidelines:

- Two of the side lengths are known.
- The student may be given information about the triangle in the preamble and/or a picture.
- It must be a right triangle.
- Difficulty level can be altered by giving students a verbal description and a picture, or by giving them a verbal description only, etc.

TM4e
Stimulus: The student is presented with a right triangle in a real-world context.

Example Stem: Bob uses a 20 foot ladder to paint a section of his house that is 16 feet high.



Select **all** equations that can be used to solve for θ.

A. $\sin\theta = \frac{12}{20}$

B. $\cos\theta = \frac{12}{20}$

C. $\tan\theta = \frac{12}{20}$

D. $\sin\theta = \frac{16}{20}$

E. $\cos\theta = \frac{16}{20}$

F. $\tan\theta = \frac{16}{20}$

Rubric: (1 point) The student is able to identify all correct equations (e.g., B,D).
Response Type: Multiple Choice, multiple correct response

Task Model 4

Response Type:
Equation/Numeric

DOK Level 2

G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Evidence Required:
4. Student uses the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical or real-world context.

Tools: Calculator

Prompt Features: The student is asked to find a missing side length or angle measure of a right triangle that can be used to model a real-world situation. Examples of right triangles in context include but are not limited to: survey problems, height of an object, navigation, ramps, shadows, etc.

Stimulus Guidelines:

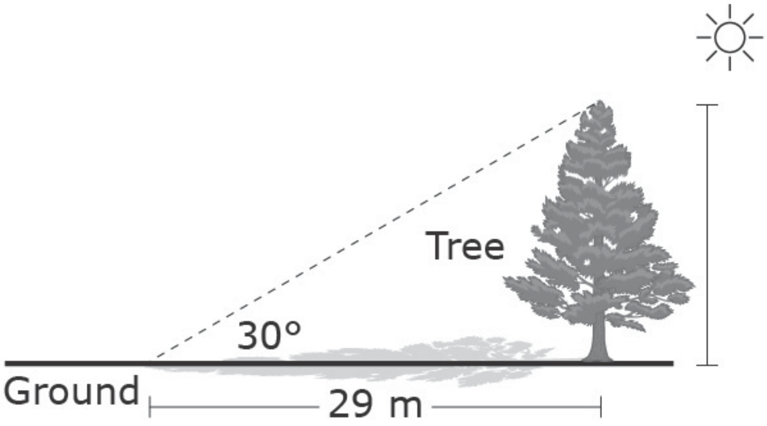
- Two of the side lengths are known.
- The student may be given information about the triangle in the preamble and/or a picture.
- It must be a right triangle.
- Difficulty level can be altered by giving students a verbal description and a picture, or by giving them a verbal description only, etc.

TM4f

Stimulus: The student is provided with information in context to be able to create a situation in which a right triangle can be created to help solve a problem in context. A picture may/may not be provided.

Example Stem: Donna wants to calculate the height of a tree. She makes the following measurements.

- The length of the tree's shadow is 29 meters.
- The angle of elevation from the ground to the top of the tree is 30°.



Enter the height of the tree, in meters. Round your answer to the nearest whole meter.

Rubric:
(1 point) The student finds the missing side of the right triangle (e.g., 17).

Response Type: Equation/Numeric

Task Model 1

Response Type: Multiple Choice, single correct response

DOK Level 2

S-ID.1
Represent data with plots on the real number line (dot plots, histograms, and box plots).

Evidence Required:
1. The student will be able to represent data on the real number line with a dot plot, histogram, or box plot.

Tools: None

Prompt Features: The student is prompted to identify the plot of a given data set.

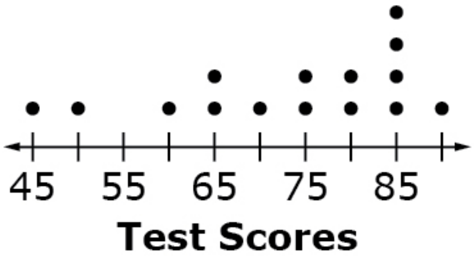
Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but is not limited to these methods:

- Presence of repeated values in the data set
- Presence of clusters and/or outliers
- Student selects dot plots.
- Student selects histograms.
- Student selects box plots.

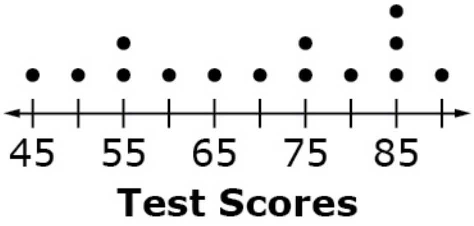
TM1a
Stimulus: The student is presented with a contextual data set.

Example Stem 1: Select the dot plot that represents the given test scores.

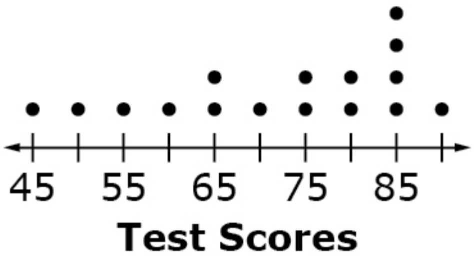
90, 45, 85, 70, 85, 50, 75, 85, 65, 75, 60, 85, 80, 65, 80



A.



B.



C.

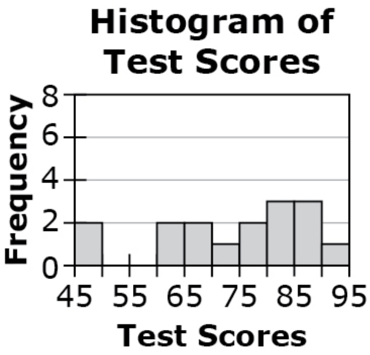
D.

Rubric: (1 point) The student selects the correct option (e.g., A).

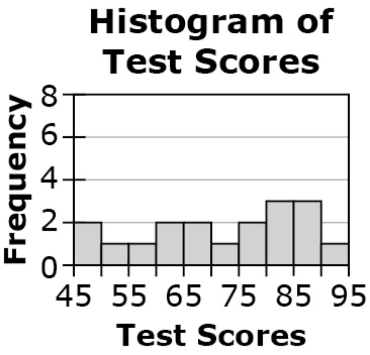
Example Stem 2: Select the histogram that represents the given test scores.

91, 48, 86, 73, 86, 49, 77, 86, 64, 78, 64, 82, 68, 82, 68, 82

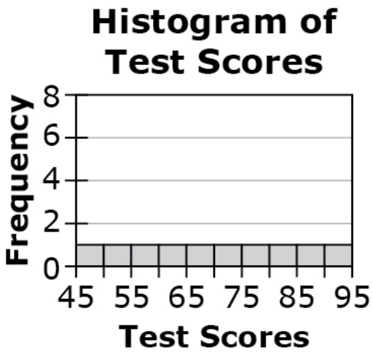
A.



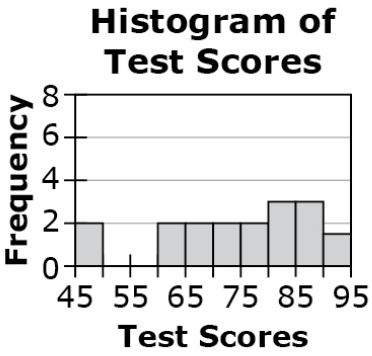
B.



C.



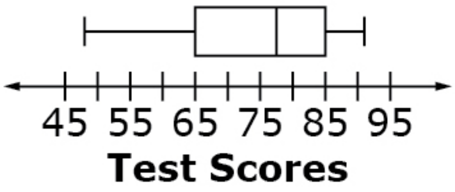
D.



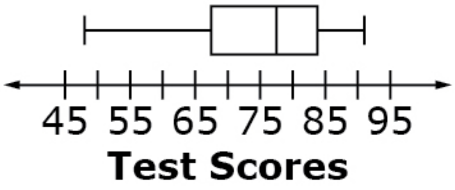
Rubric: (1 point) The student selects the correct option (e.g., A).

Example Stem 3: Select the box plot that represents the given test scores.

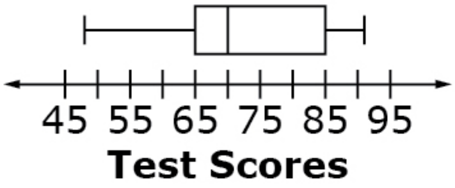
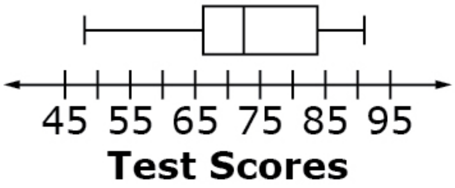
91, 48, 86, 73, 86, 50, 77, 86, 64, 78, 64, 82, 68, 82, 68, 82



A.



B.

	C.  D.  **Rubric:** (1 point) The student selects the correct option (e.g., A). **Response Type:** Multiple Choice, single correct response

Task Model 1

Response Type:
Hot Spot

DOK Level 2

S-ID.1
Represent data with plots on the real number line (dot plots, histograms, and box plots).

Evidence Required:
1. The student will be able to represent data on the real number line with a dot plot, histogram, or box plot.

Tools: None

Prompt Features: Student is prompted to create a plot of a given data set.

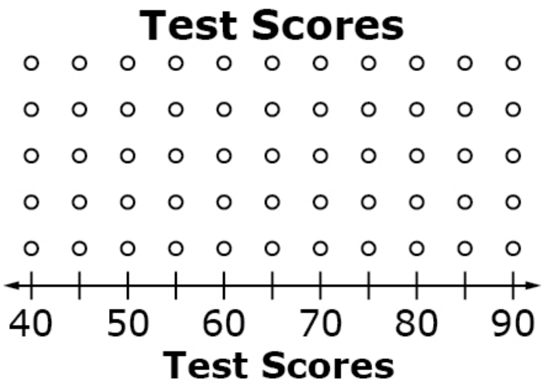
Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but is not limited to these methods:

- Presence of repeated values in the data set
- Presence of clusters and/or outliers
- Student creates dot plots.
- Student creates histograms.

TM1b
Stimulus: The student is presented with a contextual data set and a blank plot to be completed in order to represent the data.

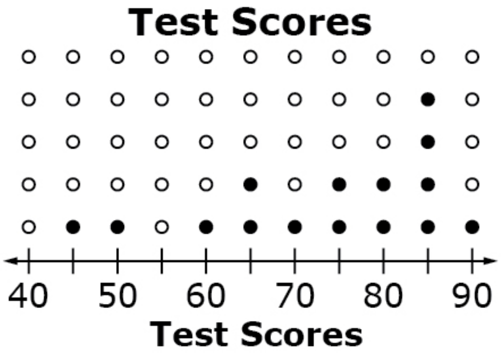
Example Stem 1: Click above the numbers to create a dot plot for the given test scores.

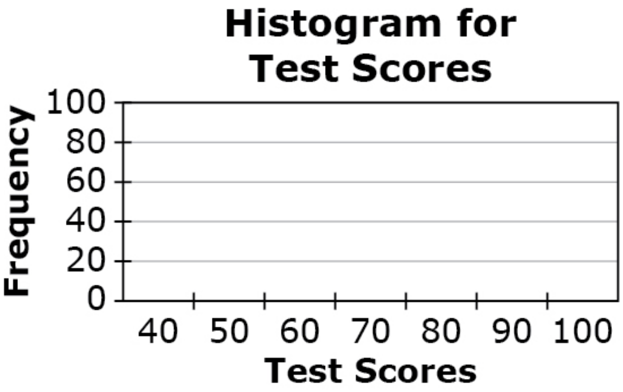
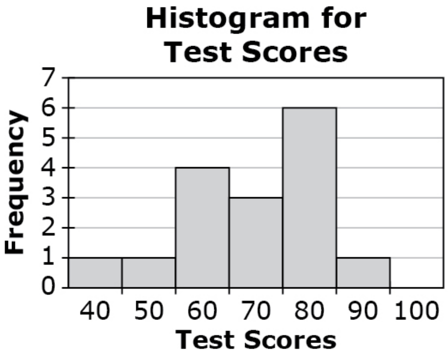
90, 45, 85, 70, 85, 50, 75, 85, 65, 75, 60, 85, 80, 65, 80



Interaction: Student selects the appropriate number of circles on the dot plot given the data.

Rubric:
(1 point) Student gets 100% correct (see below).



	Example Stem 2: Click above the line to create a histogram for the given test scores. 91, 48, 86, 73, 86, 50, 77, 86, 64, 78, 64, 82, 68, 82, 68, 82  **Interaction:** Student selects the appropriate frequency for each interval on the histogram. **Rubric:** (1 point) Student gets 100% correct (see below).  **Response Type:** Hot Spot

Task Model 1

Response Type: Drag and Drop

DOK Level 2

S-ID.1
Represent data with plots on the real number line (dot plots, histograms, and box plots).

Evidence Required:
1. The student will be able to represent data on the real number line with a dot plot, histogram, or box plot.

Tools: Calculator

Prompt Features: Student is prompted to find key features of a box plot given a data set.

Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but is not limited to these methods:

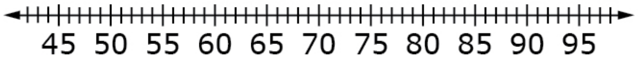
- The quantity of data points
- Having to compute an average to determine the quartiles

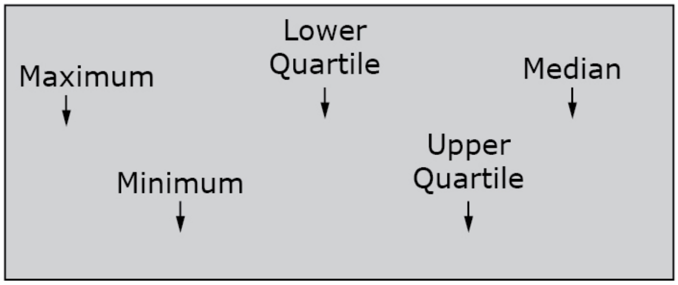
TM1c
Stimulus: The student is presented with a contextual data set, key features of box plots, and a number line.

Example Stem: Consider these test scores.

91, 48, 86, 73, 86, 50, 77, 86, 64, 78, 64, 82, 68, 82, 68, 82

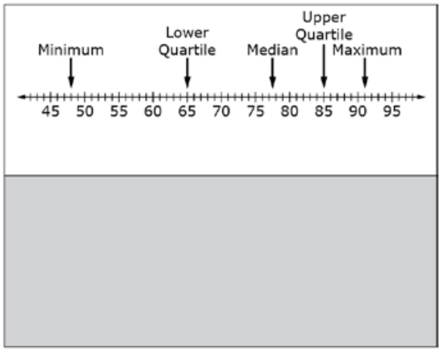
Drag each characteristic of data to the correct location on the number line.



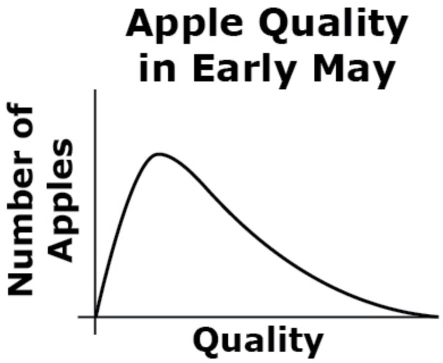
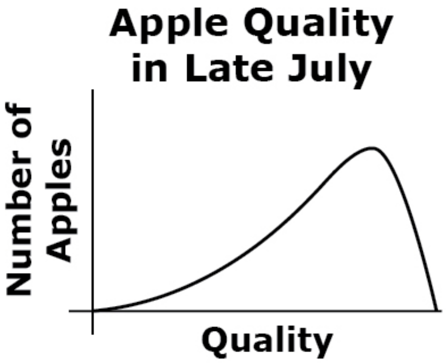


Interaction: Student drags each characteristic to the appropriate location on the number line.

Rubric:
(2 points) Student gets all five characteristics correct.
(1 point) Student gets three or four characteristics correct.
Reasoning: Knowing the minimum, maximum, and median of a data set is one level of understanding, knowing the quartile is another.



Response Type: Drag and Drop

Task Model 2 **Response Type: Multiple Choice, single correct response** **DOK Level 2** **S-ID.2** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. **Evidence Required:** 2. The student will be able to use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. **Tools:** Calculator	**Prompt Features:** Student is prompted to select the appropriate statistics to compare the center and/or spread based on data distributions. **Stimulus Guidelines:** Student is presented with a context and two distributions. **TM2** **Stimulus:** The student is presented with two data distributions in which both are skewed or both are distributed normally. **Example Stem:** Data distributions are shown for the quality of a farm's red apples at different points in time during the harvest season.   Which summary statistics should be used to compare the two data sets and why? A. The median and the interquartile range because the data sets are normally distributed. B. The median and the interquartile range because both data sets are skewed. C. The mean and standard deviation because the data sets are normally distributed. D. The mean and standard deviation because both data sets are skewed. **Rubric:** (1 point) The student selects the correct option (e.g., B). **Response Type:** Multiple Choice, single correct response

Task Model 3

Response Type: Matching Tables

DOK Level 2

S-ID.3
Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

Evidence Required: 3. The student will be able to interpret the differences in shape, center, and spread in the context of the data sets. 4. The student will be able to interpret the effects of outliers on the shape, center, and spread of a data set.

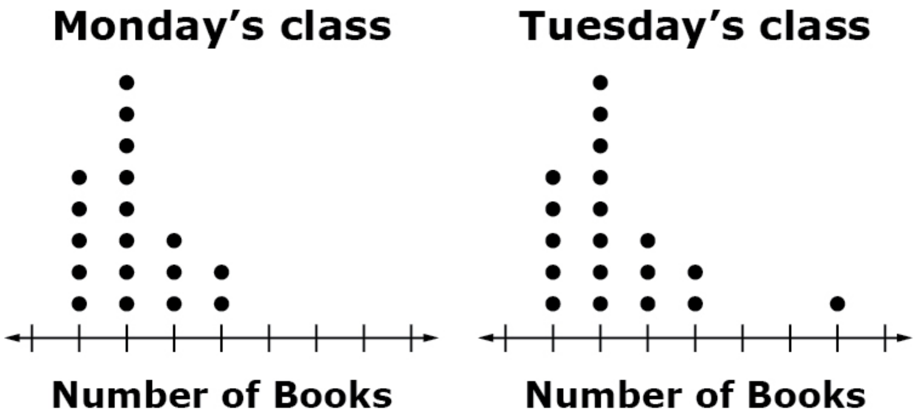
Tools: Calculator

Prompt Features: The student is prompted to identify the effect of the removal or addition of outliers on the shape, center, and/or spread of the given data sets.

Stimulus Guidelines: Item difficulty can be adjusted via these example methods, but is not limited to these methods:
- Type of plots
- Student is presented with dot plots.
- Student is presented with histograms.
- Student is presented with box plots or verbal descriptions.

TM3
Stimulus: The student is presented with data sets or plots of data sets.
- Graphs and data sets should include at least 1 outlier.
- Graphs and data sets should each have no more than 20 data values.

Example Stem 1: On Monday, Mr. Dickens asked his class how many books they read last month and set up a dot plot showing the information. On Tuesday, Walter joined the class and his information was added to the dot plot.



Select whether the value of each statistic, for the number of books read, is greater for Monday's class, equal for both days, or greater for Tuesday's class based on the dot plots.

	Greater for Monday's Class	Equal for Both Days	Greater for Tuesday's Class
Mean			
Median			
Standard Deviation			

Interaction: Student selects the correct box for each statistic.

Example Stem 2: A car dealership has 41 cars for sale. The least expensive car costs $11,999. The most expensive car costs $19,499. Another car, priced at $33,499, is added to the dealership's inventory. Select whether the value of each statistic, for the prices of the cars, increases, decreases, or cannot be determined when the new car is added.

	Increases	**Decreases**	**Cannot Be Determined**
Mean			
Median			
Standard Deviation			

Interaction: Student selects the correct box for each statistic.

Rubric: (1 point) Student selects all of the correct options (e.g., Greater for Tuesday's, Equal for Both Days, Greater for Tuesday's; Increases, Cannot Be Determined, Increases).

Response Type: Matching Tables