Claim 1: Concepts and Procedures Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.	
Content Domain: **Algebra**	
Target H [m]: Understand solving equations as a process of reasoning and explain the reasoning. (DOK 1, 2) Tasks for this target will require students to solve radical and rational equations in one variable. Tasks that ask students to critique or justify a particular solution method will contribute evidence to Claim 3.	
Standards: A-REI.A, A-REI.A.2	**A-REI.A Understand solving equations as a process of reasoning and explain the reasoning.** **A-REI.A.2** Solve simple rational and radical equations in one variable and give examples showing how extraneous solutions may arise.
Related Below-Grade Standards for Purposes of Planning for Vertical Scaling: 8.EE.A, 8.EE.A.1, 8.EE.A.2 8.EE.C, 8.EE.C.7, 8.EE.C.7a, 8.EE.C.7b	**Related Grade 8 standards** **8.EE.A Work with radicals and integer exponents.** **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. **8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form $x^2=p$ and $x^3=p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. **8.EE.C Analyze and solve linear equations and pairs of simultaneous linear equations.** **8.EE.C.7.** Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.
DOK Levels:	1, 2

Achievement Level Descriptors:	
RANGE Achievement Level Descriptors (Range ALD) Target H: Understand solving equations as a process of reasoning and explain the reasoning.	**Level 1** Students should be able to explain solution steps for solving one-step linear equations in one variable.
	Level 2 Students should be able to look for and make use of structure to solve simple radical equations and simple rational equations in one variable in which the variable term is in the numerator and should understand the solution steps as a process of reasoning. They should be able to understand and explain solution steps for solving linear equations in one variable as a process of reasoning.
	Level 3 Students should be able to look for and make use of structure to solve simple radical and rational equations in one variable presented in various forms. They should be able to understand and explain solution steps for solving quadratic, radical, and rational equations in one variable as a process of reasoning.
	Level 4 Students should be able to give examples showing how extraneous solutions may arise and why they arise when solving linear, quadratic, radical, and rational equations.
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). 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. 3. The student solves radical or rational equations in multiple variables. 4. The student identifies equivalent equations to an equation with rational or radical expressions.
Allowable Item Types:	Multiple Choice, single correct response; Equation/Numeric; Matching Tables
Allowable Stimulus Materials:	simple radical and rational equations
Construct-Relevant Vocabulary:	radical, rational, real, solution
Allowable Tools:	None
Target-Specific Attributes:	
Non-Targeted Constructs:	

Accessibility Guidance:	Item writers should consider the following Language and Visual Element/Design guidelines[1] when developing items. Language Key Considerations: • Use simple, clear, and easy-to-understand language needed to assess the construct or aid in the understanding of the context • Avoid sentences with multiple clauses • Use vocabulary that is at or below grade level • Avoid ambiguous or obscure words, idioms, jargon, unusual names and references Visual Elements/Design Key Considerations: • Include visual elements only if the graphic is needed to assess the construct or it aids in the understanding of the context • Use the simplest graphic possible with the greatest degree of contrast, and include clear, concise labels where necessary • Avoid crowding of details and graphics Items are selected for a student's test according to the blueprint, which selects items based on Claims and targets, not task models. As such, careful consideration is given to making sure fully accessible items are available to cover the content of every Claim and target, even if some item formats are not fully accessible using current technology.[2]
Development Notes:	Items that assess A.REI.A and A.REI.A.1 will be measured in Claim 3.

[1] For more information, refer to the General Accessibility Guidelines at: http://www.smarterbalanced.org/wordpress/wp-content/uploads/2012/05/TaskItemSpecifications/Guidelines/AccessibilityandAccommodations/GeneralAccessibilityGuidelines.pdf

[2] For more information about student accessibility resources and policies, refer to http://www.smarterbalanced.org/wordpress/wp-content/uploads/2014/08/SmarterBalanced_Guidelines.pdf

Task Model 1

Response Type:
Equation / numeric

DOK Levels 1, 2

A-REI.A.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 for a rational or radical equation.

Stimulus Guidelines:

- The student is presented with an equation that contains a rational or radical expression.
  - The equation must have at least one solution.
  - Solutions must be rational numbers.
  - Standard procedures for solving the equation should not produce extraneous roots.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The variable is present on only one side of the equation.
  - There are multiple rational expressions on both sides of the equation.
  - There are multiple rational expressions with differing denominators.
  - There are radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable.
  - There are 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 rational solution.

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 *t* that makes the equation true.

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

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

Response Type: Equation/numeric

Task Model 1 **Response Type:** **Equation / numeric** **DOK Levels 1, 2** **A-REI.A.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 *n* that make the equation true. $n - 1 = \sqrt{5n - 9}$ 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.A.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 for a rational or radical equation.

Stimulus Guidelines:

- The student is presented with an equation that contains a rational or radical expression.
  - Solutions, if they exist, must be rational numbers.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The variable is present on only one side of the equation.
  - There are multiple rational expressions on both sides of the equation.
  - There are multiple rational expressions with differing denominators.
  - There are radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable.
  - There are 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 solutions, 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.A.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 two real solutions.

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

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, two real solutions, or infinitely many real solutions.

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

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.A.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:

- The student is presented with an equation that contains a rational or radical expression.
  - The equation has one or more rational solutions.
- Item difficulty can be adjusted via these example methods, but are not limited to these methods:
  - The variable is present on only one side of the equation.
  - There are multiple rational expressions on both sides of the equation.
  - There are multiple rational expressions with differing denominators.
  - There are radicals of the form $\sqrt{ax}$ where *a* is a constant and *x* is a variable.
  - There are 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 *b* is a solution to the given equation.

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

Solution	Yes	No
$b = 3$		
$b = \frac{5}{3}$		
$b = \frac{3}{5}$		

Rubric: (1 point) The student correctly determines whether each value of *b* 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.A.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

Version 3 Update:
Revised wording of example stems 1 and 2 and the corresponding options.

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

Stimulus Guidelines:

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

Example Stem 1: A student was finding the solutions to the equation $1+\sqrt{x-3}=0$ and wrote the four steps 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 student made an error in Step 1.
B. The student made an error in Step 3.
C. The student found the correct solution to the original equation, $x = 4$.
D. $x=4$ 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.A.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

Version 3 Update:
Revised wording of example stems 1 and 2 and the corresponding options.

Example Stem 2: A student was finding the solutions to the equation $\sqrt{t^2-5}-2=0$ and wrote the five steps shown.

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

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

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

Step 4: $t^2=9$

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

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

A. The student made an error in Step 1.
B. The student made an error in Step 3.
C. The student made an error in Step 4.
D. The student found the correct solutions to the equation, $t=3$ and $t=-3$.
E. $t=3$ and $t=-3$ are solutions 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 3 **Response Type: Equation / Numeric** **DOK Level 2** **A-REI.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **Evidence Required:** 3. The student solves radical or rational equations in multiple variables. **Tools:** None **Version 3 Update:** Added new "Evidence required" statement 3 and new task models TM3a and TM3b.	**Prompt Features:** The student is given an equation with more than one variable that reduces to a rational or radical equation in one variable when values for the other variables are given. The student is asked to solve the equation for given values of the other variables. **Stimulus Guidelines**: • The equation has multiple variables. The student is given values for all but one of the variables. The equation reduces to a simple rational or radical equation. • The solution must be rational. If the student reports the solution as a decimal, it should be rounded to the nearest tenth. • Equations should use a variety of letters for the variables. **TM3a** **Stimulus:** The student is presented with an equation in more than one variable and is given all values for the other variables. **Example Stem 1:** For the given equation, enter the value of V when $r = 300$. $r = 10\sqrt{V}$ **Example Stem 2:** For the given equation, enter the value of R when $I = 18$ and $V = 9$. $I = \frac{V}{R}$ **Rubric:** (1 point) The student enters the correct solution(s) (e.g., 900; ½ or 0.5). **Response Type:** Equation/Numeric

Task Model 3 **Response Type: Equation / Numeric** **DOK Level 2** **A-REI.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **Evidence Required:** 3. The student solves radical or rational equations in multiple variables. **Tools:** None **Version 3 Update:** Added new "Evidence required" statement 3 and new task models TM3a and TM3b.	**Prompt Features:** The student is given an equation with more than one variable that is linear in one of the variables. The student is asked to solve for that variable in terms of the other variables. **Stimulus Guidelines**: • The equation has multiple variables and is linear in one or more of those variables. • 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 an equation in more than one variable that has rational or radical expressions and is asked to solve for one of the variables. **Example Stem 1:** Solve the given equation for *v*. $t = \frac{\sqrt{v}}{3}$ Complete the equation in the response box. **Example Stem 2:** Solve the given equation for *h*. $B = \frac{V}{h}$ Complete the equation in the response box. **Rubric:** (1 point) The student enters the correct equation (e.g., $v = 9t^2$; $h = \frac{V}{B}$). **Response Type:** Equation/Numeric [Label the response box with the letter the equation is being solved for (e.g., *v* = ☐)].

Task Model 4

Response Type:
Matching Tables

DOK Level 2

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

Evidence Required:
4. The student identifies equivalent equations to an equation with rational or radical expressions.

Tools: None

Version 3 Update:
Added new "Evidence required" statement 4 and new task model TM4.

Prompt Features: Given an equation in one variable with rational or radical expressions, identify equivalent equations.

Stimulus Guidelines:

- The student is presented with a rational or radical equation in one variable and another set of equations.
- The student must identify which of the equations in the set are equivalent to the first.

TM4
Stimulus: The stem will present an equation in one variable with rational or radical expressions and 3 or more equations that are likely to arise from common algebraic manipulations of the equation.

Example Stem: Equivalent equations have exactly the same solution set. Select Yes or No to indicate whether each equation is equivalent to the given equation.

Given: $\sqrt{t+1}+5=0$

Equation	Yes	No
$\sqrt{t+1}=-5$		
$t+1=25$		
$t=24$		

Rubric: (1 point) The student correctly determines whether each equation is equivalent (e.g., YNN).

Response Type: Matching Tables