

<p><b>Claim 1: Concepts and Procedures</b>                  Students can explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency.</p>	
<p>Content Domain: <b>Number and Quantity</b></p>	
<p><b>Target A [m]:</b> Extend the properties of exponents to rational exponents.</p> <p>Tasks for this target will require students to use the definition of radicals and rational exponents and identify equivalent numeric and algebraic expressions involving rational exponents and radicals. Tasks for this target will require students to find the exact value of numbers expressed in terms of rational exponents or estimate their magnitude, where appropriate. Claim 3 tasks will tap student understanding of the properties of exponents and their ability to identify flawed reasoning applied to this target.</p>	
<p>Standards:                   N-RN.A, N-RN.A.1,                  N-RN.A.2</p>	<p><b>N-RN.A Extend the properties of exponents to rational exponents.</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p>
<p>Related Below-Grade Standards for Purposes of Planning for Vertical Scaling:                   8.EE.A,                  8.EE.A.1, 8.EE.A.2</p>	<p><b>Related Grade 8 standards</b></p> <p><b>8.EE.A Work with radicals and integer exponents.</b></p> <p><b>8.EE.A.1</b> Know and apply the properties of integer exponents to generate equivalent numerical expressions.</p> <p><b>8.EE.A.2</b> Use square root and cube root symbols to represent solutions to equations of the form <math>x^2 = p</math> and <math>x^3 = p</math>, where <math>p</math> is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that the square root of two is irrational.</p>
<p>DOK Levels:</p>	<p>1, 2</p>
<p><b>Achievement Level Descriptors:</b></p>	
<p><b>RANGE Achievement Level Descriptor (Range ALD)</b>                  Target A:                  Extend the properties of exponents to rational exponents.</p>	<p><b>Level 1</b> Students should be able to rewrite expressions with rational exponents of the form <math>(1/n)</math> to radical form and vice versa.</p>
	<p><b>Level 2</b> Students should be able to look for and use structure to extend the properties of integer exponents to multiply and divide expressions with rational exponents that have common denominators.</p>
	<p><b>Level 3</b> Students should be able to rewrite expressions with rational exponents of the form <math>(m/n)</math> to radical form, and vice versa, and look for and use structure to extend the properties of integer exponents to all laws of exponents on radical expressions and expressions with rational exponents.</p>
	<p><b>Level 4</b> Students should be able to identify the exponent property used when rewriting expressions, and recognize when laws of exponents cannot be used to rewrite an expression.</p>
<p>Evidence Required:</p>	<p>1. The student rewrites expressions in radical form into an equivalent expression with rational exponents.</p> <p>2. The student rewrites expressions with rational exponents into an equivalent expression in radical form.</p>

	<p>3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.</p> <p>4. The student solves equations that require an understanding of the definitions of radicals and rational exponents.</p> <p>5. The student finds exact or approximate values of numeric expressions involving rational exponents or radicals.</p> <p>6. The student compares expressions involving rational exponents or radicals with other numbers.</p>
Allowable Response Types:	Multiple Choice, single correct response; Multiple Choice, multiple correct response; Equation/Numeric; Matching Tables
Allowable Stimulus Materials:	numerical expressions involving radicals, numerical expressions involving rational exponents, algebraic expressions involving radicals, algebraic expressions involving rational exponents
Construct-Relevant Vocabulary:	exponent, radical, rational exponent
Allowable Tools:	None
Target-Specific Attributes:	properties of integer exponents, properties of rational exponents
Non-Targeted Constructs:	
Accessibility Guidance:	<p>Item writers should consider the following Language and Visual Element/Design guidelines<sup>1</sup> when developing items.</p> <p>Language Key Considerations:</p> <ul style="list-style-type: none"> <li>• Use simple, clear, and easy-to-understand language needed to assess the construct or aid in the understanding of the context</li> <li>• Avoid sentences with multiple clauses</li> <li>• Use vocabulary that is at or below grade level</li> <li>• Avoid ambiguous or obscure words, idioms, jargon, unusual names and references</li> </ul> <p>Visual Elements/Design Key Considerations:</p> <ul style="list-style-type: none"> <li>• Include visual elements only if the graphic is needed to assess the construct or it aids in the understanding of the context</li> <li>• Use the simplest graphic possible with the greatest degree of contrast, and include clear, concise labels where necessary</li> <li>• Avoid crowding of details and graphics</li> </ul> <p>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.<sup>2</sup></p>

<sup>1</sup> 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>

<sup>2</sup> For more information about student accessibility resources and policies, refer to [http://www.smarterbalanced.org/wordpress/wp-content/uploads/2014/08/SmarterBalanced\\_Guidelines.pdf](http://www.smarterbalanced.org/wordpress/wp-content/uploads/2014/08/SmarterBalanced_Guidelines.pdf)

<p><b>Task Model 1</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 1. The student rewrites expressions in radical form into an equivalent expression with rational exponents.</p> <p><b>Tools:</b> None</p>	<p><b>Prompt Features:</b> Given an expression that includes radicals, identify an equivalent expression that includes rational exponents.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>For radicals (e.g., <math>\sqrt[q]{p^r}</math>) <math>p</math> may be either a number (except 0 or 1), or a variable.</li> <li>Item difficulty can be adjusted via these example methods, but are not limited to these methods:             <ul style="list-style-type: none"> <li>Expressions can be given in <math>\sqrt[q]{p^r}</math> form where <math>p</math> is a number (except 0 or 1).</li> <li>Expressions can be given in <math>\sqrt[q]{p^r}</math> form where <math>p</math> is a variable.</li> <li>Expressions can be given in <math>\sqrt[q]{p^{\frac{s}{r}}}</math> form where <math>p</math> is a number (except 0 or 1), or a variable.</li> </ul> </li> </ul> <p><b>TM1a</b> <b>Stimulus:</b> The student will be presented with an expression of the form <math>\sqrt[q]{p^r}</math>.</p> <p><b>Example Stem:</b> Select an expression that is equivalent to <math>\sqrt[9]{3^6}</math>.</p> <p>A. <math>3^{\frac{2}{3}}</math> B. <math>3^{\frac{3}{2}}</math> C. <math>3^3</math> D. <math>3^{15}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent rational form (e.g., A).</p> <p><b>TM1b</b> <b>Stimulus:</b> The student will be presented with an expression of the form <math>\sqrt[q]{p^{\frac{s}{r}}}</math>.</p> <p><b>Example Stem:</b> Select an expression that is equivalent to <math>\sqrt[4]{x^{\frac{2}{3}}}</math>.</p> <p>A. <math>x^{\frac{1}{4}}</math> B. <math>x^{\frac{9}{4}}</math> C. <math>x^{\frac{1}{6}}</math> D. <math>x^{\frac{8}{3}}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent rational form (e.g., C).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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<p><b>Task Model 2</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 2. The student will be able to rewrite expressions with rational exponents into an equivalent expression in radical form.</p> <p><b>Tools:</b> None</p>	<p><b>Prompt Features:</b> Given an expression that includes rational exponents, identify an equivalent expression that includes radicals.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For rational exponents (e.g., <math>p^{\frac{r}{q}}</math>) <math>p</math> may be either:             <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient.</li> </ul> </li> <li>• Item difficulty can be adjusted via these example methods, but are not limited to these methods:             <ul style="list-style-type: none"> <li>○ Expressions can be given as <math>p^{\frac{r}{q}}</math> where <math>p</math> is a number (except 0 or 1).</li> <li>○ Expressions can be given as <math>p^{\frac{r}{q}}</math> where <math>p</math> is a variable that may or may not have an integer coefficient.</li> </ul> </li> </ul> <p><b>TM2a</b> <b>Stimulus:</b> The student will be presented with an expression of the form <math>p^{\frac{r}{q}}</math>.</p> <p><b>Example Stem:</b> Select an expression that is equivalent to <math>3^{\frac{6}{9}}</math>.</p> <p>A. <math>\sqrt[9]{3^6}</math>              B. <math>\sqrt[6]{3^9}</math>              C. <math>\sqrt{3^3}</math>              D. <math>\sqrt[3]{3}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent radical form (e.g., A).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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<p><b>Task Model 2</b></p> <p><b>Response Type:</b> <b>Matching Tables</b></p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 2. The student will be able to rewrite expressions with rational exponents into an equivalent expression in radical form.</p> <p><b>Tools:</b> None</p>	<p><b>Prompt Features:</b> Given an expression that includes rational exponents, identify an equivalent expression that includes radicals.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For rational exponents (e.g., <math>p^{\frac{r}{q}}</math>) <math>p</math> may be either:             <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient.</li> </ul> </li> <li>• Item difficulty can be adjusted via these example methods, but are not limited to these methods:             <ul style="list-style-type: none"> <li>○ Expressions can be given as <math>p^{\frac{r}{q}}</math> where <math>p</math> is a number (except 0 or 1).</li> <li>○ Expressions can be given as <math>p^{\frac{r}{q}}</math> where <math>p</math> is a variable that may or may not have an integer coefficient.</li> </ul> </li> </ul> <p><b>TM2b</b> <b>Stimulus:</b> The student will be presented with an expression of the form <math>p^{\frac{r}{q}}</math>.</p> <p><b>Example Stem 1:</b> Determine whether each expression is equivalent to <math>x^{\frac{5}{3}}</math>. Select Yes or No for each expression.</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 60%;"></th> <th style="width: 20%;">Yes</th> <th style="width: 20%;">No</th> </tr> </thead> <tbody> <tr> <td><math>\sqrt{x}</math></td> <td></td> <td></td> </tr> <tr> <td><math>\sqrt[3]{x^5}</math></td> <td></td> <td></td> </tr> <tr> <td><math>\sqrt[5]{x^3}</math></td> <td></td> <td></td> </tr> <tr> <td><math>\sqrt{x^{\frac{5}{3}}}</math></td> <td></td> <td></td> </tr> </tbody> </table> <p><b>Example Stem 2:</b> Determine whether each expression is equivalent to <math>(2x^3)^{\frac{2}{5}}</math>. Select Yes or No for each expression.</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 60%;"></th> <th style="width: 20%;">Yes</th> <th style="width: 20%;">No</th> </tr> </thead> <tbody> <tr> <td><math>\sqrt[5]{4x^6}</math></td> <td></td> <td></td> </tr> <tr> <td><math>x^5\sqrt{4}</math></td> <td></td> <td></td> </tr> <tr> <td><math>\sqrt[5]{2x^6}</math></td> <td></td> <td></td> </tr> <tr> <td><math>x^5\sqrt{4x}</math></td> <td></td> <td></td> </tr> <tr> <td><math>\sqrt[5]{4x^3}</math></td> <td></td> <td></td> </tr> </tbody> </table> <p><b>Rubric:</b> (1 point) The student correct identifies the equivalent expression(s) (e.g. NYNN; YNNYN)</p> <p><b>Response Type:</b> Matching Tables</p>		Yes	No	$\sqrt{x}$			$\sqrt[3]{x^5}$			$\sqrt[5]{x^3}$			$\sqrt{x^{\frac{5}{3}}}$				Yes	No	$\sqrt[5]{4x^6}$			$x^5\sqrt{4}$			$\sqrt[5]{2x^6}$			$x^5\sqrt{4x}$			$\sqrt[5]{4x^3}$		
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<p><b>Task Model 3</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.</p> <p><b>Tools:</b> None</p>	<p><b>Prompt Features:</b> Given an expression that includes radicals, identify an equivalent expression that includes rational exponents.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For radicals (e.g., <math>\sqrt[q]{p^r}</math>, <math>\sqrt[q]{p^r}</math>, <math>\sqrt[t]{p^s}</math>), for rational exponents (e.g., <math>p^{\frac{r}{q}}</math>, <math>p^{\frac{s}{t}}</math>, <math>p^{\frac{m}{n}}</math>) and for complex expressions (e.g., <math>p^{\frac{r}{q}}(\sqrt[t]{p^s} + p^m)</math>; <math>\sqrt[q]{p^{\frac{r}{s}}}</math>; <math>\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}}</math>, <math>\frac{p^{\frac{r}{q}}}{\sqrt[t]{p^s}}</math>) <math>p</math> may be either:             <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient, provided that there are no other variables in the expression.</li> </ul> </li> <li>• For rational exponents, <math>n</math>, <math>q</math>, or <math>t</math> may be a variable provided that the corresponding <math>m</math>, <math>r</math>, or <math>s</math> is the same variable.</li> <li>• Item difficulty can be adjusted via these example methods, but are not limited to these methods:             <ul style="list-style-type: none"> <li>○ <math>p</math> can be a number (except 0 or 1), or equation is in <math>\sqrt[q]{p^{\frac{r}{m}}} = p^{\frac{s}{t}}</math> form with one variable.</li> <li>○ <math>p</math> can be a number (except 0 or 1) or a variable with or without an integer coefficient, or equation is in <math>\sqrt[q]{p^r} \cdot \sqrt[t]{p^s} = p^{\frac{m}{n}}</math>, or <math>p^{\frac{r}{q}} \cdot p^{\frac{s}{t}} = \sqrt[n]{p^m}</math> form with one variable.</li> </ul> </li> </ul> <p><b>TM3a</b> <b>Stimulus:</b> The student will be presented with an expression in the form <math>\sqrt[q]{p^r} \cdot \sqrt[t]{p^s}</math>.</p> <p><b>Example Stem 1:</b> Select an expression that is equivalent to <math>\sqrt[4]{4^2} \cdot \sqrt[4]{4^3}</math>.</p> <p>A. <math>4^{\frac{4}{5}}</math>              B. <math>4^{\frac{4}{6}}</math>              C. <math>4^{\frac{5}{4}}</math>              D. <math>4^{\frac{6}{4}}</math></p> <p><b>Example Stem 2:</b> Select an expression that is equivalent to <math>\sqrt[4]{2x^2} \cdot \sqrt[4]{2x^3}</math>.</p> <p>A. <math>2^{\frac{1}{2}}x^{\frac{6}{2}}</math>              B. <math>2^{\frac{2}{4}}x^{\frac{5}{4}}</math>              C. <math>4^{\frac{1}{3}}x^{\frac{5}{2}}</math>              D. <math>4^{\frac{4}{2}}x^{\frac{1}{4}}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent rational form (e.g., C; B).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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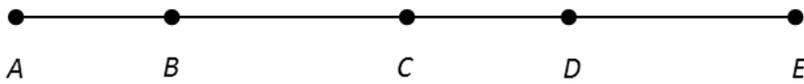
<p><b>Task Model 3</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.</p> <p><b>Tools:</b> None</p>	<p><b>Prompt Features:</b> Given an expression that includes rational exponents, identify an equivalent expression that includes radicals.</p> <p><b>Stimulus Guidelines for TM3b and TM3c:</b> same as for TM3a</p> <p><b>TM3b</b> <b>Stimulus:</b> The student will be presented with an expression in the form <math>p^{\frac{r}{q}} \cdot p^{\frac{s}{t}}</math>.</p> <p><b>Example Stem 1:</b> Select an expression that is equivalent to <math>16^{\frac{1}{4}} \cdot 16^{\frac{2}{3}}</math>.</p> <p>A. <math>\sqrt[12]{16^{11}}</math>          B. <math>\sqrt[7]{16^3}</math>          C. <math>\sqrt[12]{16^2}</math>          D. <math>\sqrt[6]{16^4}</math></p> <p><b>Example Stem 2:</b> Select an expression that is equivalent to <math>\left(\frac{1}{3}\right)x^{\frac{1}{4}} \cdot \left(\frac{1}{3}\right)x^{\frac{2}{3}}</math>.</p> <p>A. <math>\sqrt[12]{3x^2}</math>          B. <math>\sqrt[6]{\left(\frac{1}{3}\right)x^4}</math>          C. <math>\frac{1}{9}\sqrt[12]{x^{11}}</math>          D. <math>\frac{1}{3}\sqrt[12]{x^2}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent radical form (e.g., A; C).</p> <p><b>TM3c</b> <b>Stimulus:</b> The student will be presented with an expression of the form <math>p^{\frac{r}{q}}(\sqrt[t]{p^s} + p^m)</math>.</p> <p><b>Example Stem:</b> Select an expression that is equivalent to <math>8^{\frac{1}{3}}(\sqrt[3]{8^2} + 8^2)</math>.</p> <p>A. <math>\sqrt{8^9} + 8^{\frac{3}{7}}</math>          B. <math>\sqrt[3]{8^3} + 8^{\frac{7}{3}}</math>          C. <math>\sqrt[7]{8^3} + 8^{\frac{3}{2}}</math>          D. <math>\sqrt[9]{8^2} + 8^{\frac{7}{3}}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent radical form (e.g., C).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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<p><b>Task Model 3</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>Equation/Numeric</b></p> <p><b>DOK Level 1</b></p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 3. The student uses the properties of exponents to write equivalent expressions involving radicals and rational exponents.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b> Retired TM3h and TM3i.</p>	<p><b>Prompt Features:</b> Solve for a variable that will create equivalent expressions with radicals and rational exponents.</p> <p><b>Stimulus Guidelines for TM3d - TM3g:</b> same as for TM3a</p> <p><b>TM3d</b> <b>Stimulus:</b> The student will be presented with an equation of the form <math>\sqrt[q]{p^{\frac{r}{m}}} = p^{\frac{s}{t}}</math>.</p> <ul style="list-style-type: none"> <li><math>m, q, r, s,</math> or <math>t</math> may be replaced with a variable.</li> </ul> <p><b>Example Stem:</b> Enter the value of <math>x</math> such that <math>\sqrt[4]{64^{\frac{1}{3}}} = 64^{\frac{1}{x}}</math> is true.</p> <p><b>TM3e</b> <b>Stimulus:</b> The student will be presented with an equation in the form <math>\sqrt[q]{p^r} \cdot \sqrt[t]{p^s} = p^{\frac{m}{n}}</math>.</p> <ul style="list-style-type: none"> <li><math>m, n, q, r, s,</math> or <math>t</math> may be replaced with a variable.</li> </ul> <p><b>Example Stem:</b> Enter the value of <math>x</math> such that <math>\sqrt[3]{27^2} \cdot \sqrt[3]{27^5} = 27^{\frac{x}{3}}</math> is true.</p> <p><b>TM3f</b> <b>Stimulus:</b> The student will be presented with an equation in the form <math>p^{\frac{r}{q}} \cdot p^{\frac{s}{t}} = \sqrt[n]{p^m}</math>.</p> <ul style="list-style-type: none"> <li><math>m, n, q, r, s,</math> or <math>t</math> may be replaced with a variable.</li> </ul> <p><b>Example Stem:</b> Enter the value of <math>x</math> such that <math>3^{\frac{4}{5}} \cdot 3^{\frac{3}{x}} = \sqrt[5]{3^7}</math> is true.</p> <p><b>TM3g</b> <b>Stimulus:</b> The student will be presented with an equation of the form <math>\frac{p^{\frac{r}{q}}}{p^{\frac{s}{t}}} = \sqrt[n]{p^m}</math>.</p> <ul style="list-style-type: none"> <li><math>m, n, q, r, s,</math> or <math>t</math> may be replaced with a variable.</li> </ul> <p><b>Example Stem:</b> Enter the value of <math>x</math> such that <math>\frac{16^{\frac{5}{4}}}{16^{\frac{1}{x}}} = \sqrt[3]{16^3}</math> is true.</p> <p><b>Rubric:</b> (1 point) The student enters the correct value of the variable (e.g., 12; 7; 5; 4).</p> <p><b>Response Type:</b> Equation/Numeric</p>
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<p><b>Task Model 4</b></p> <p><b>Response Type:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 2</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 4. The student solves equations that require an understanding of the definitions of radicals and rational exponents.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b> Added new “Evidence Required” statement 4 and new TM4a, TM4b, and TM4c.</p>	<p><b>Prompt Features:</b> Solve an equation that requires an understanding of the definitions of radicals and rational exponents.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>Equations will be of the form <math>x^m = a^n</math> or <math>x^m = \sqrt[n]{a}</math> <ul style="list-style-type: none"> <li><math>m</math>, <math>n</math>, and <math>a</math> are integers</li> </ul> </li> <li>Distractors in the answer choices should reflect the standard confusion between the meaning of negative integer exponents and rational exponents.</li> <li>“The equation has no solution” should be included as an answer choice in all items in this task model, and some items should have this as the correct option.</li> </ul> <p><b>TM4a</b> <b>Stimulus:</b> The student will be presented with an equation of the form <math>x^m = a^n</math>.</p> <p><b>Example Stem 1:</b> Which of the following is a solution to the equation <math>x^3 = 25</math>?</p> <p>A. <math>x = 5^{\frac{2}{3}}</math>          B. <math>x = 5^{\frac{3}{2}}</math>          C. <math>x = 25^{\frac{2}{3}}</math>          D. <math>x = 25^{-3}</math>          E. This equation has no solution.</p> <p><b>Example Stem 2:</b> Which of the following is a solution to the equation <math>x^3 = \frac{1}{49}</math>?</p> <p>A. <math>x = 7^{\frac{2}{3}}</math>          B. <math>x = 7^{\frac{3}{2}}</math>          C. <math>x = 7^{-\frac{2}{3}}</math>          D. <math>x = 7^{-\frac{3}{2}}</math>          E. This equation has no solution.</p> <p><b>Example Stem 3:</b> Which of the following is a solution to the equation <math>x^2 = -36</math>?</p> <p>A. <math>x = 6</math>          B. <math>x = -6</math>          C. <math>x = 18</math>          D. <math>x = -18</math>          E. This equation has no solution.</p> <p><b>Rubric:</b> (1 point) The student selects the correct option (e.g., A; C; E).</p> <p><b>Response Type:</b> Multiple choice, single correct response</p>
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<p><b>Task Model 4</b></p> <p><b>Response Types:</b>  <b>Multiple Choice, single correct response;</b></p> <p><b>Multiple Choice, multiple correct response</b></p> <p><b>DOK Level 2</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b>  Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b>  4. The student solves equations that require an understanding of the definitions of radicals and rational exponents.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b>  Added new "Evidence Required" statement 4 and new TM4a, TM4b, and TH4c.</p>	<p><b>TM4b</b>  <b>Stimulus:</b> The student will be presented with an equation of the form <math>x^m = \sqrt[n]{a}</math>.</p> <p><b>Example Stem:</b> Which of the following is a solution to the equation <math>x^5 = \sqrt[3]{4}</math>?</p> <p>A. <math>x = (\sqrt[3]{4})^5</math>  B. <math>x = \sqrt[15]{4}</math>  C. <math>x = \sqrt[3]{20}</math>  D. <math>x = \frac{\sqrt[3]{4}}{5}</math>  E. This equation has no solution.</p> <p><b>Rubric:</b>  (1 point) The student selects the correct option (e.g., B).</p> <p><b>Response Type:</b> Multiple choice, single correct response</p> <p><b>TM4c</b>  <b>Stimulus:</b> The student will be presented with an equation of the form <math>x^m = a</math>.</p> <ul style="list-style-type: none"> <li><math>m</math> and <math>a</math> are integers.</li> </ul> <p><b>Example Stem:</b> Which of the following is a solution to the equation <math>x^3 = 17</math>? Select <b>all</b> that apply.</p> <p>A. <math>x = 17^3</math>  B. <math>x = 17^{\frac{1}{3}}</math>  C. <math>x = \sqrt[3]{17}</math>  D. <math>x = \frac{1}{\sqrt[3]{17}}</math>  E. This equation has no solution.</p> <p><b>Rubric:</b>  (1 point) The student selects the correct options (e.g., B, C).</p> <p><b>Response Type:</b> Multiple choice, multiple correct response</p>
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<p><b>Task Model 5</b></p> <p><b>Response Types:</b>  <b>Multiple Choice, multiple correct response</b></p> <p><b>Multiple Choice, single correct response</b></p> <p><b>DOK Level 2</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b>                  Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b>                  5. The student finds exact or approximate values of numeric expressions involving rational exponents or radicals.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b>                  Added new "Evidence Required" statement 5 and new TM5a, TM5b, and TM5c.</p>	<p><b>Prompt Features:</b> Students will be presented with a numeric expression involving rational exponents or radicals and will be required to find the exact or approximate value of the numeric expression.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For radicals (e.g., <math>\sqrt[q]{p^r}</math>) <math>p</math> may be either a number (except 0 or 1) or a variable.</li> <li>• For rational exponents (e.g., <math>p^{\frac{r}{q}}</math>) <math>p</math> may be either:                         <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient.</li> </ul> </li> </ul> <p><b>TM5a</b>  <b>Stimulus:</b> The student will be presented with an expression of the form <math>\sqrt[n]{a^m x^p}</math> and asked to identify an equivalent expression.</p> <ul style="list-style-type: none"> <li>• <math>a</math>, <math>m</math>, <math>n</math>, and <math>p</math> are integers.</li> </ul> <p><b>Example Stem:</b> Select <b>all</b> of the expressions that are equivalent to <math>\sqrt[4]{100x^6}</math>.</p> <p>A. <math>\sqrt{10x^3}</math>                  B. <math>x\sqrt{10x}</math>                  C. <math>\sqrt[4]{100x^2}</math>                  D. <math>25x^{1.5}</math>                  E. <math>25x^2</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent expressions (e.g., A, B, C).</p> <p><b>Response Type:</b> Multiple Choice, multiple correct response</p> <p><b>TM5b</b>  <b>Stimulus:</b> The student will be presented with an expression of the form <math>p^n</math> and asked to identify an equivalent expression.</p> <ul style="list-style-type: none"> <li>• <math>p</math> is an integer</li> <li>• <math>n</math> can be a fraction or decimal number</li> </ul> <p><b>Example Stem:</b> Which number is equal to <math>5^{-\frac{1}{2}}</math> ?</p> <p>A. <math>5^2</math>                  B. <math>\frac{1}{5^2}</math>                  C. <math>-5^2</math>                  D. <math>\frac{1}{\frac{1}{5^2}}</math></p> <p><b>Rubric:</b> (1 point) The student correctly selects the equivalent expression (e.g., D).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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<p><b>Task Model 5</b></p> <p><b>Response Types:</b> Multiple Choice, single correct response</p> <p><b>DOK Level 2</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 5. The student finds exact or approximate values of numeric expressions involving rational exponents or radicals.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b> Added new "Evidence Required" statement 5 and new TM5a, TM5b, and TM5c.</p>	<p><b>Prompt Features:</b> Students will be presented with a numeric expression involving rational exponents or radicals and will be required to find the exact or approximate value of the numeric expression.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For radicals (e.g., <math>\sqrt[q]{p^r}</math>) <math>p</math> may be either a number (except 0 or 1) or a variable.</li> <li>• For rational exponents (e.g., <math>p^{\frac{r}{q}}</math>) <math>p</math> may be either:             <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient.</li> </ul> </li> </ul> <p><b>TM5c</b> <b>Stimulus:</b> The student will be presented with a segment length in radical form.</p> <p><b>Example Stem:</b> Segment AE shown has length <math>\sqrt{20}</math>.</p>  <p>Which segment is closest in length to <math>\sqrt{10}</math>?</p> <p>A. <math>\overline{AB}</math> B. <math>\overline{AC}</math> C. <math>\overline{AD}</math> D. <math>\overline{DE}</math></p> <p><b>Rubric:</b> (1 point) The student selects the correct segment (e.g., C).</p> <p><b>Response Type:</b> Multiple Choice, single correct response</p>
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<p><b>Task Model 6</b></p> <p><b>Response Types:</b> Multiple Choice, multiple correct response</p> <p><b>DOK Level 2</b></p> <p><b>N-RN.A.1</b> Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</p> <p><b>N-RN.A.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> <p><b>Evidence Required:</b> 6. The student compares expressions involving rational exponents or radicals with other numbers.</p> <p><b>Tools:</b> None</p> <p><b>Version 3 Update:</b> Added new "Evidence Required" statement 6 and new TM6.</p>	<p><b>Prompt Features:</b> Students will be presented with a numeric expression involving rational exponents or radicals and will be required to compare the expression to other numbers.</p> <p><b>Stimulus Guidelines:</b></p> <ul style="list-style-type: none"> <li>• For radicals (e.g., <math>\sqrt[q]{p^r}</math>) <math>p</math> may be either a number (except 0 or 1) or a variable.</li> <li>• For rational exponents (e.g., <math>p^{\frac{r}{q}}</math>) <math>p</math> may be either:             <ul style="list-style-type: none"> <li>○ a number (except 0 or 1), or</li> <li>○ a multi-term expression, or</li> <li>○ a variable with an integer coefficient.</li> </ul> </li> </ul> <p><b>TM6</b></p> <p><b>Stimulus:</b> The student will be presented with an expression of the form <math>p^n</math> and asked to identify a true statement of equivalency or comparison to other numbers.</p> <ul style="list-style-type: none"> <li>• <math>p</math> is an integer</li> <li>• <math>n</math> can be a fraction or decimal number</li> </ul> <p><b>Example Stem:</b> Select <b>all</b> the statements about the number <math>9^{0.4}</math> that are true.</p> <ul style="list-style-type: none"> <li>A. <math>9^{0.4}</math> is greater than 3.</li> <li>B. <math>9^{0.4}</math> is equal to 3.6.</li> <li>C. <math>9^{0.4}</math> raised to the fifth power equals 81.</li> <li>D. <math>9^{0.4}</math> multiplied by 10 equals <math>9^4</math>.</li> <li>E. <math>9^{0.4}</math> is less than <math>3^{0.9}</math></li> </ul> <p><b>Rubric:</b> (1 point) The student correctly selects the true statements (e.g., B, E).</p> <p><b>Response Type:</b> Multiple Choice, multiple correct response</p>
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