HS Target A

Domain, Target, Standards, DOK, Vertical Alignments, Achievement Levels, Evidence Required, Vocabulary, Response Types, Materials, Attributes, Question Types, and Question Banks (Examples)

Content Domain: Number and Quantity
Target A [s]: N-RN.A Extend the properties of exponents to rational exponents.
Standards included in Target A: N-RN.A, N-RN.A.1, N-RN.A.2
Vertical Alignment
Achievement Level Descriptors
Evidence Required
Vocabulary
Response Types
Materials
Attributes
Claim 1: Concepts and Procedures (DOK 1, 2) Question Banks
Claim 3 Communicating Reasoning Question Banks

Content Domain: Number and Quantity

Target A [s]: N-RN.A Extend the properties of exponents to rational exponents.

Standards included in Target A: N-RN.A, N-RN.A.1, N-RN.A.2

N-RN.A Extend the properties of exponents to rational exponents.

N-RN.A.1 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.

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

Vertical Alignment

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 the square root of two is irrational.

Achievement Level Descriptors

Level 1 Students should be able to rewrite expressions with rational exponents of the form (1/n) to radical form and vice versa.

Level 2 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.

Level 3 Students should be able to rewrite expressions with rational exponents of the form (m/n) 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.

Level 4 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.

Evidence Required

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

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

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

4. The student solves equations that require an understanding of the definitions of radicals and rational exponents.

5. The student finds exact or approximate values of numeric expressions involving rational exponents or radicals.

6. The student compares expressions involving rational exponents or radicals with other numbers.

Vocabulary

exponent, radical, rational exponent

Response Types

Multiple Choice, single correct response; Multiple Choice, multiple correct response; Equation/Numeric; Matching Tables

Materials
numerical expressions involving radicals, numerical expressions involving rational exponents, algebraic expressions involving radicals, algebraic expressions involving rational exponents

Attributes
properties of integer exponents, properties of rational exponents

Claim 1: Concepts and Procedures (DOK 1, 2) Question Banks
Students can explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency.

Claim 1 N-RN.A.2 DOK Level 1

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

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

Question Type 1: The student will be presented with an expression of the form $\sqrt[q]{p^r}$.

1. 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).

Question Type 2: The student will be presented with an expression of the form $\sqrt[q]{p^{\frac{s}{r}}}$.

1. 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., A).

Response Type: Multiple Choice, single correct response

Claim 1 N-RN.A.2 DOK Level 1
Rewrite expressions involving radicals and rational exponents using the properties of exponents.

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

Question Type 1: The student will be presented with an expression of the form $p^{\frac{r}{q}}$.

1. 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

Question Type 2: The student will be presented with an expression of the form $p^{\frac{r}{q}}$.

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

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

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

Claim 1 N-RN.A.2 DOK Level 1
Rewrite expressions involving radicals and rational exponents using the properties of exponents.

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

Question Type 1: The student will be presented with an expression in the form $\sqrt[q]{p^r} \cdot \sqrt[t]{p^s}$.

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. $4^{\frac{6}{4}}$

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

Question Type 2: The student will be presented with an expression in the form $p^{\frac{r}{q}} \cdot p^{\frac{s}{t}}$.

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. $\sqrt[6]{16^4}$

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. $\frac{1}{3}\sqrt[12]{x^2}$

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

Question Type 3: The student will be presented with an expression of the form $p^{\frac{r}{q}}(\sqrt[t]{p^s} + p^m)$.

1. 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

Question Type 4: The student will be presented with an equation in the for $p^{\frac{r}{q}} \cdot p^{\frac{s}{t}} = \sqrt[n]{p^m}$.

• m, n, q, r, s, or t may be replaced with a variable.

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

Question Type 5: 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.

1. Enter the value of x such that $\sqrt[3]{27^2} \cdot \sqrt[3]{27^5} = 27^{\frac{x}{3}}$ is true.

Question Type 6: 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.

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Question Type 7: 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.

1. 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., 12; 7; 5; 4).

Response Type: Equation/Numeric

Claim 1 N-RN.A.1 & N-RN.A.2 DOK Level 1

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.

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

Evidence Required:
The student solves equations that require an understanding of the definitions of radicals and rational exponents.

Question Type 1: The student will be presented with an equation of the form $x^m = a^n$.

1. Which of the following is a solution to the equation $x^3=2^5$?

A. $x = 5^{\frac{2}{3}}$
B. $x = 5^{\frac{3}{2}}$
C. $x = 25^{\frac{2}{3}}$
D. $x = 25^{-3}$
E. This equation has no solution.

2. Which of the following is a solution to the equation $x^3 = \frac{1}{49}$?

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3. Which of the following is a solution to the equation $x^2=-3^6$?

A. x = 6
B. x = −6
C. x = 18
D. x = −18
E. This equation has no solution.

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

Response Type: Multiple choice, single correct response

Claim 1 N-RN.A.1 & N-RN.A.2 DOK Level 2

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.

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

Evidence Required:
The student solves equations that require an understanding of the definitions of radicals and rational exponents.

Question Type 1: The student will be presented with an equation of the form $x^m = \sqrt[n]{a}$.

1. Which of the following is a solution to the equation $x^5 = \sqrt[3]{4}$?

A. $x = (\sqrt[3]{4})^5$
B. $x = \sqrt[15]{4}$
C. $x = \sqrt[3]{20}$
D. $x = \frac{\sqrt[3]{4}}{5}$
E. This equation has no solution.

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

Response Type: Multiple choice, single correct response

Question Type 2: The student will be presented with an equation of the form $x^m = a$.

- m and a are integers.

1. Which of the following is a solution to the equation $x^3 = 17$? Select all that apply.

A. $x = 17^3$
B. $x = 17^{\frac{1}{3}}$
C. $x = \sqrt[3]{17}$
D. $x = \frac{1}{\sqrt[3]{17}}$
E. This equation has no solution.

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

Response Type: Multiple choice, multiple correct response

Claim 1 N-RN.A.1 & N-RN.A.2 DOK Level 2

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.

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

Evidence Required:
The student finds exact or approximate values of numeric expressions involving rational exponents or radicals.

Question Type 1: The student will be presented with an expression of the form $\sqrt[n]{a^m x^p}$ and asked to identify an equivalent expression.

- a, m, n, and p are integers.

1. Select all of the expressions that are equivalent to $\sqrt[4]{100x^6}$.

A. $\sqrt{10x^3}$
B. $x\sqrt{10x}$
C. $\sqrt[4]{100x^2}$
D. $25x^{1.5}$
E. $25x^2$

Rubric: (1 point) The student correctly selects the equivalent expressions (e.g., A, B, C).

Response Type: Multiple Choice, multiple correct response

Question Type 2: The student will be presented with an expression of the form p^n and asked to identify an equivalent expression.

- p is an integer
- n can be a fraction or decimal number

1. Which number is equal to $5^{-\frac{1}{2}}$?

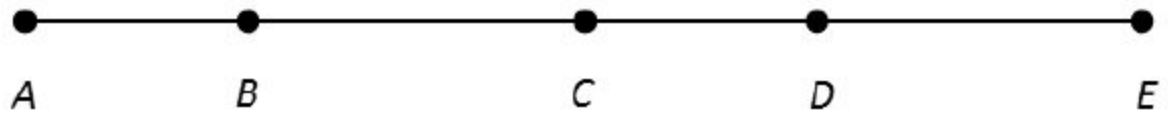
A. 5^2
B. $\frac{1}{5^2}$
C. -5^2
D. $\frac{1}{5^{\frac{1}{2}}}$

Rubric: (1 point) The student correctly selects the equivalent expression (e.g., D).

Response Type: Multiple Choice, single correct response

Question Type 2: The student will be presented with a segment length in radical form.

1. Segment AE shown has length $\sqrt{20}$.



Which segment is closest in length to $\sqrt{10}$?

A. $\overline{AB}$
B. $\overline{AC}$
C. $\overline{AD}$
D. $\overline{DE}$

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

Response Type: Multiple Choice, single correct response

Claim 1 N-RN.A.1 & N-RN.A.2 DOK Level 2

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.

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

Evidence Required:
The student compares expressions involving rational exponents or radicals with other numbers.

Question Type 1: The student will be presented with an expression of the form p^n and asked to identify a true statement of equivalency or comparison to other numbers.

- p is an integer
- n can be a fraction or decimal number

1. Select all the statements about the number 90.4 that are true.
   A. 90.4 is greater than 3.
   B. 90.4 is equal to 3.6.
   C. 90.4 raised to the fifth power equals 81.
   D. 90.4 multiplied by 10 equals 9^4.
   E. 90.4 is less than $3^{0.9}$

Rubric: (1 point) The student correctly selects the true statements (e.g., B, E).

Response Type: Multiple Choice, multiple correct response

Claim 3 Communicating Reasoning Question Banks

Claim Descriptors and Targets

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Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.

Example 1

Consider this inequality: $\sqrt[3]{m} \leq m$

Part A:
Determine the positive values of m for which the inequality is true.
Enter your response as an inequality in the first response box.

Part B:
Determine the positive values of m for which the inequality is false.
Enter your response as an inequality in the second response box.

Rubric: (2 points) The student provides the values that make the given inequality true ($m \geq 1$) and false ($0 < m < 1$). (1 point) The student errors in the use of the inequality signs (uses > instead of ≥ or ≤ instead of <) but otherwise has the correct range of values. OR The student is able to provide an example of where the statement is true (e.g., a positive value greater than or equal to 1) and a number between 0 and 1 that makes the statement false.

Response Type: Equation/Numeric