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5.1 nth roots, Radicals and Rational Exponents

$\sqrt[2]{9} = 9^{1/2}$ $\quad \sqrt[3]{9} = 9^{1/3}$ $\quad (\sqrt[3]{27})^2 = 27^{2/3}$

ex] write expression in radical form

a) $x^{3/4}$

$(\sqrt[4]{x})^3$ * Notice where the 3 and 4 go *

b) $10^{1/4} = (\sqrt[4]{10})^1$

ex] write the expression in exponent form

a) $(\sqrt[3]{8})^2 = 8^{2/3}$

ex] Evaluate

a) $16^{3/4} = 16 \wedge (3 \div 4) = 8$

b) $\sqrt[5]{3.5^4} = 3.5^4 \wedge (1 \div 5) = 2.72$

ex] Solve the equation

a) $\frac{5x^3}{5} = \frac{320}{5}$

$(x^3)^{1/3} = (64)^{1/3}$ (to get rid of cube, raise to 1/3)

$x = 4$

b) $\frac{2p^4}{2} = \frac{162}{2}$

$(p^4)^{1/4} = (81)^{1/4}$ (raise to 1/4)

$p = \pm 3$ * Don't forget ± when even exponent *

ex] Simplify

a) $\sqrt[3]{8x^5y^4}$

$4 \quad 2$

$1 \quad 1$

$2 \quad 2$

Look for groups of 3 → $\sqrt[3]{2 \cdot 2 \cdot 2 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y} = 2xy\sqrt[3]{x^2y}$

Part I (Review W.S.)

5.2 Properties of Exponents and Radicals

Exponent Properties

1. **Product**

$a^m \cdot a^n = a^{m+n}$

ex) $x^3 \cdot x^4 = x^7$

2. **Quotient**

$\frac{a^m}{a^n} = a^{m-n}$ ex) $\frac{x^7}{x^3} = x^{7-3} = x^4$

3. **Power of Power**

$(a^m)^n = a^{m \cdot n}$ ex) $(x^4)^5 = x^{20}$

4. **Power of Product**

$(a^m)^n = a^{m \cdot n}$ ex) $(x^2y^3)^4 = x^8y^{12}$

5. **Negative Exponents**

$a^{-m} = \frac{1}{a^m}$ ex) $\frac{x^2y^{-3}}{z^{-4}}$ ★ only move negative ★

$\frac{1}{a^{-m}} = \frac{a^m}{1}$

$\frac{x^2z^4}{y^3}$

over →

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5.2 Part 2

Write the Product in radical form

a) $\sqrt[5]{16} \cdot \sqrt[5]{8}$

$\sqrt[5]{128} =$ Look for groups of 5

$\sqrt[5]{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}$

$2\sqrt[5]{4}$

64 (2)

8 8

2 2 2 2 2 2

b) $\sqrt[4]{27x^2} \cdot \sqrt[4]{3x}$

$\sqrt[4]{81x^3} =$ group of 4

$\sqrt[4]{3 \cdot 3 \cdot 3 \cdot 3 \cdot x \cdot x \cdot x}$

$3\sqrt[4]{x^3}$

9 9

3 3 3 3

Write the quotient in radical form

ex) $\sqrt[3]{\frac{108x^7}{2x^2}} = \sqrt[3]{54x^5} = \sqrt[3]{2 \cdot 3 \cdot 3 \cdot 3 \cdot x \cdot x \cdot x \cdot x \cdot x}$

9 6

3 3 2 3

$3x\sqrt[3]{2x^2}$

b) $\sqrt[3]{\frac{2n}{9m}}$

$\frac{\sqrt[3]{2n}}{\sqrt[3]{9m}} \cdot \frac{\sqrt[3]{9m}}{\sqrt[3]{9m}} = \frac{\sqrt[3]{18mn}}{9m}$

Over →

Add or & Subtract ✱ must have same radical

ex] $3\sqrt{7} + 2\sqrt{7}$ → same → combine outside → $5\sqrt{7}$

b) $\sqrt{20} + \sqrt{5}$ (Notice not the same)

$4 \cdot 5$

$2 \cdot 2$

$\sqrt{2 \cdot 2 \cdot 5}$

$2\sqrt{5} + \sqrt{5}$ (Now the same)

$3\sqrt{5}$

Multiply

ex] $\sqrt[3]{7}(2 - \sqrt[3]{49})$

$2\sqrt[3]{7} - \sqrt[3]{49 \cdot 7}$ $\quad \sqrt[3]{7 \cdot 7 \cdot 7} = 7$

$2\sqrt[3]{7} - 7$

b) $(2x - \sqrt{3})(2x - \sqrt{3})$ (FOIL)

$4x^2 - 2x\sqrt{3} - 2x\sqrt{3} + \sqrt{9}$

$4x^2 - 4x\sqrt{3} + 3$

Rationalize a Denominator

ex] $\frac{1}{2+\sqrt{5}}$ (multiply by conjugate)

$\frac{1}{2+\sqrt{5}}\left(\frac{2-\sqrt{5}}{2-\sqrt{5}}\right)$ $\quad \frac{2-\sqrt{5}}{4 - 2\sqrt{5} + 2\sqrt{5} - 5}$ $\quad = \frac{2-\sqrt{5}}{-1}$

cancel

$-2 + \sqrt{5}$

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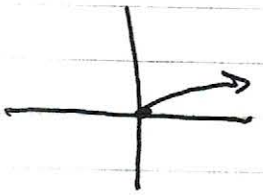
5.3 Graphing Radical Functions

Parent Function

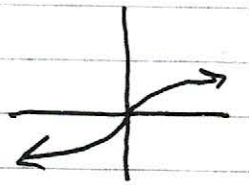
Square Root

$y = \sqrt{x}$



Cube root

$y = \sqrt[3]{x}$



Square Root

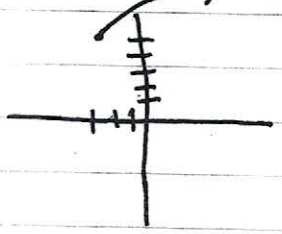
$f(x) = a\sqrt{x-h} + k$

- a: Stretch or Compression
- h: left or right
- k: up or down

ex] Describe the transformation

a) $f(x) = 2\sqrt{x+3} + 5$

2: stretched; $x+3$: left 3; $+5$: up 5



b) Find domain and range

$d: x \geq -3$

$r: y \geq 5$

Cube Root

ex] $h(x) = \frac{1}{3}\sqrt[3]{x-2} + 3$

$\frac{1}{3}$: Compression; $x-2$: right 2; $+3$: up 3

b) Find domain and range

$d = (-\infty, \infty)$

$r = (-\infty, \infty)$

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5.4 solve Radical Equations

ex] $\sqrt{x+5} - 1 = 3$ (Get radical by itself)

$+1 \quad +1$

$(\sqrt{x+5})^2 = (4)^2$ (square both sides)

$x + 5 = 16$

$-5 \quad -5$

$x = 11$ ✱ must check ✱

b) $\sqrt[3]{x} + 2 = 4$

$-2 \quad -2$

$(\sqrt[3]{x})^3 = (2)^3$ (cube both sides)

$x = 8$ ✱ must check ✱

ex] $(\sqrt{3x-2})^2 = (x-4)^2$ (square both sides)

$3x - 2 = (x-4)(x-4)$

$3x - 2 = x^2 - 4x - 4x + 16$

$3x - 2 = x^2 - 8x + 16$ (set = 0)

$-3x + 2 \qquad -3x + 2$

$0 = x^2 - 11x + 18$ (Factor)

$0 = (x-9)(x-2)$

$x - 9 = 0$ $\qquad$ $x - 2 = 0$

$x = 9$ $\qquad$ ~~$x = 2$~~ ✱ must Check

$\sqrt{3(9)-2} = 9 - 4$ $\qquad$ $\sqrt{3(2)-2} = 2 - 4$

$\sqrt{25} = 5$ ✓ $\qquad$ $\sqrt{4} = -2$ does not check out

2 = extranzous

over →

ex] $(x^2+5x+5)^{5/2} = (1)^{2/5}$ (raise each side to 2/5)

$x^2+5x+5 = 1$ (set = 0)

$-1 \quad -1$

$x^2+5x+4=0$ (Factor)

$(x+4)(x+1)=0$

$x+4=0 \qquad x+1=0$

$x=-4 \qquad x=-1$ * Check *

ex] $(x)^2 (\sqrt{7x+8})^2$

$x^2 = 7x+8$

$x^2-7x-8=0$

$(x-8)(x+1)=0$

$x-8=0 \qquad x+1=0$

$+8 \quad +8 \qquad -7 \quad -1$

$x=8 \qquad \cancel{x=-1}$

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5.5 Function Operations

ex) $f(x) = 3x+4$
$g(x) = x^2-5x+2$

a) $f+g$
$(3x+4)+(x^2-5x+2)$
x^2-2x+6

b) $f-g$
$(3x+4)-(x^2-5x+2)$
$-x^2+8x+2$

c) $f \cdot g$
$(3x+4)(x^2-5x+2)$ (Distribute)
$3x^3-15x^2+6x+4x^2-20x+8$
$3x^3-11x^2-14x+8$

d) $\frac{f}{g}$
$\frac{3x+4}{x^2-5x+2}$ Nothing cancels

Composition

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

a) $f \circ g = f(g(x))$ (g substitutes into f)
$(x^2+x+2) \circ (4-x)$
$(4-x)^2+(4-x)+2$
$(4-x)(4-x)+(4-x)+2$
$16-4x-4x+x^2+(4-x)+2$
$x^2-9x+22$

Over

b) $g \circ g = g(g(x))$

$g(x) = 4 - x$ $\quad g(x) = 4 - x$

$4 - (4 - x) = x$

c) $f(g(3))$

$f(x) = x^2 + x + 2$ $\quad g(x) = 4 - x$ (substitute 3)

$= 4 - 3$

$= 1$ (substitute in $f(x)$)

$= 1^2 + 1 + 2$

$= 4$

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5.6 Inverse Relations and Functions

Inverse - switch the x and y and then solve for y

Function - If the x repeats then it is <u>not</u> a function

ex] Find the inverse

x	-1	0	1	2	3	4
y	9	7	5	3	1	-1

Inverse

x^{-1}	9	7	5	3	1	-1
y^{-1}	-1	0	1	2	3	4

b) Is the inverse a function?
Yes, x does not repeat

ex] Find the inverse

a) $f(x) = 4x - 2$

$y = 4x - 2$ (switch x and y)

$x = 4y - 2$ (solve for y)

$+2 \quad +2$

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

$y^{-1} = \frac{x}{4} + \frac{1}{2}$

b) $f(x) = 2 - \sqrt[3]{x+1}$

$y = 2 - \sqrt[3]{x+1}$

$x = 2 - \sqrt[3]{y+1}$

$-2 \quad -2$

$x - 2 = -\sqrt[3]{y+1}$

$-1 \quad -1$

$(-x+2)^3 = \left(\sqrt[3]{y+1}\right)^3$ (cube both sides)

$(-x+2)^3 = y+1$

$-1 \quad -1$

$(-x+2)^3 - 1 = y^{-1}$