Ch. 1.2 - Radical Operations (part 1)

- Changing integer exponents to rational exponents requires finding an \( n\text{th} \) root.

\( n\text{th} \) Root: If \( a \) and \( x \) are real numbers and \( n \) is a positive integer, then \( x \) is an \( n\text{th} \) root of \( a \) if \( x^n = a \).

**Introduction of Radical Sign:**

If \( x^n = a \), then \( x = \sqrt[n]{a} \)

*Principal Square Root is ALWAYS positive! (Sq. Rt. of non-variable positive real #)*

**\( n\text{th} \) Root Theorems:** (using \( x = \sqrt[n]{a} \))

1) If \( a \) is positive and \( n \) is even, then there exist **two** real \( n\text{th} \) roots;

   a) \( x^2 = 16 \)
   
   \[ \sqrt{x^2} = \sqrt{16} \]
   
   \[ \begin{align*}
   x &= \sqrt{16} \\
   x &= -\sqrt{16} \\
   x &= 4 \\
   x &= -4
   \end{align*} \]

   \( x = 4, \quad x = -4 \)

   \( (-4)^2 = (4)^2 = 16 \)

   b) \( x^2 = 11 \)
   
   \[ \sqrt{x^2} = \sqrt{11} \]
   
   \[ \begin{align*}
   x &= \sqrt{11} \\
   x &= -\sqrt{11}
   \end{align*} \]

   \( x = \sqrt{11}, \quad x = -\sqrt{11} \)

   \( x \) decimals only asked at this level.

c) \( x^4 = 81 \)
   
   \[ 4\sqrt{x^4} = 4\sqrt{81} \]
   
   \[ \begin{align*}
   x &= 4\sqrt{81} \\
   x &= -4\sqrt{81} \\
   x &= 3 \\
   x &= -3
   \end{align*} \]

   \( x = 3, \quad x = -3 \)

   \( (3)^4 = (-3)^4 = 81 \)

   d) \( x^4 = 5 \)
   
   \[ 4\sqrt{x^4} = 4\sqrt{5} \]
   
   \[ \begin{align*}
   x &= 4\sqrt{5} \\
   x &= -4\sqrt{5}
   \end{align*} \]

   \( b/c \quad (-\sqrt{5})^4 = (\sqrt{5})^4 = (5^{\frac{1}{2}})^4 = 5 \)
ii) If $a$ is negative and $n$ is even, then there are NO real number solutions; $x = \sqrt[n]{a}$

eg: a) $x^2 = -25$
\[ \sqrt{x^2} = \sqrt{-25} \]
\[ \text{unsolvable} \]
\[ \text{NO SOLUTION!} \]
\[ x = \emptyset \]

b) $x^4 = -7$
\[ 4\sqrt{x^4} = 4\sqrt{-7} \]
\[ \text{NO SOLUTION} \]
\[ x = \emptyset \]

iii) If $n$ is odd, then there is ONE real $n^{th}$ root of $a$; $x = \sqrt[n]{a}$

eg: a) $x^3 = 8$
\[ 3\sqrt{x^3} = 3\sqrt{8} \]
\[ x = 2 \]
\[ b/c \ 2^3 = 8 \]

b) $x^3 = -8$
\[ \sqrt[3]{x^3} = \sqrt[3]{-8} \]
\[ x = 3\sqrt{-8} \]
\[ x = -2 \]
\[ b/c \ (-2)^3 = -8 \]

eg. $x^5 = -4$
\[ 5\sqrt{x^5} = 5\sqrt{-4} \]
\[ x = 5\sqrt{-4} \]
\[ b/c \ (\sqrt[5]{-4})^5 = (4^{1/5})^5 = -4 \]

iv) If $a$ is zero, then there is ONE real $n^{th}$ root of $a$, and it is 0; $x = \sqrt[n]{a}$

eg: $x^5 = 0$
\[ 5\sqrt{x^5} = 5\sqrt{0} \]
\[ x = 0 \]
\[ b/c \ 0^5 = 0 \]

HW: p. 9 # 1, 2, 3.
Ch. 1.2 cont'd (Part II)
Radical Properties

For any positive integer $n$:

i) \[ a^{\frac{1}{n}} = \sqrt[n]{a} \]

ii) \[ a^{\frac{m}{n}} = (a^{\frac{1}{n}})^m = (\sqrt[n]{a})^m \]

iii) \[ a^{-\frac{m}{n}} = (a^{\frac{1}{n}})^{-m} = (\sqrt[n]{a})^{-m} = \left(\frac{1}{\sqrt[n]{a}}\right)^m \]

iv) \[ \sqrt[\frac{m}{n}]{a} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}} \]

v) \[ \sqrt[\frac{m}{n}]{ab} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}} \]

Square Roots of Positive Powers of $x$

CASE 1: When $x \geq 0$ in $\sqrt{x^n}$, with $n$ a positive integer;

- If $x < 0$, $\sqrt{x}$ is UNDEFINED within $\mathbb{R}$.

EG:
\[ \sqrt{x^2} = \sqrt{(x \cdot x)} = x \]
\[ \sqrt{x^3} = \sqrt{(x)(x \cdot x)} = x \sqrt{x} \]
\[ \sqrt{x^4} = \sqrt{(x)(x)(x \cdot x)} = (x \cdot x) = x^2 \]
\[ \sqrt{x^5} = \sqrt{(x)(x)(x)(x \cdot x)} = \sqrt{x \cdot x \cdot x} = x^2 \sqrt{x} \]

etc...

CASE 2: When $x$ is a real number in $\sqrt{x^n}$, with $n$ a positive integer;

- We may require RESTRICTIONS to be placed on the expression.
If the exponent of a radicand is **even**, then a **negative** value will be changed into a **positive** value before the square root is taken:

\[
\sqrt{(-3)^2} = \sqrt{9} = 3
\]

When variables exist in a radicand, it is not known if the variable represents a **positive** or a **negative** number. An **absolute value** is sometimes needed to ensure that the result is a **positive** number (required when \( x \) changes from an **even** power to an **odd** power):

\[
\sqrt{x^2} = |x|
\]

\[
\sqrt{x^4} = x^2 \quad \text{(no absolute value needed)}
\]

\[
\sqrt{x^6} = |x^3|
\]

If the exponent in the radicand is **odd**, then a **negative** value of \( x \) will make the value negative, which is **undefined** in \( \mathbb{R} \). Therefore, \( x \geq 0 \) for all **odd exponents**:

\[
\sqrt{x^3} = x\sqrt{x} \quad ; \quad x \geq 0
\]

\[
\sqrt{x^5} = x^2\sqrt{x} \quad ; \quad x \geq 0
\]

\[
\sqrt{x^7} = x^3\sqrt{x} \quad ; \quad x \geq 0
\]
For $x, \ a > 0$

1. $\sqrt{-x}$ is **undefined** (unless $x \leq 0$)

2. $\sqrt{x} = -a$ has no real solution
   
   $-\sqrt{x} = a$ has no real solution

3. $x^2 = -a$ has no real solutions
   
   As well, through induction...
   
   for $n$, a positive integer: $x^{2n} = -a$ has no real solutions

p. 10-12 * 4-17.
Ch. 1.3 - Simplifying Radicals

Remember: Radicals can be expressed with fractional exponents.

\[ \sqrt{2} = 2^{\frac{1}{2}} \quad \sqrt[n]{x} = x^{\frac{1}{n}} \quad n \sqrt{a} = a^{\frac{1}{n}} \text{ where } n \text{ is a positive integer.} \]

Three Important Radical Relationships:

i) \( \sqrt[n]{a^n} = a \); \( a \geq 0 \)
   Why? \( \sqrt[n]{a^n} = (a^n)^{\frac{1}{n}} = a \)
   * this is also true for \( a < 0 \), if \( n \) is an odd integer.

ii) \( \sqrt[n]{ab} = \sqrt[n]{a} \cdot \sqrt[n]{b} \); \( a, b \geq 0 \)
   Why? \( \sqrt[n]{ab} = (ab)^{\frac{1}{n}} = (a^{\frac{1}{n}})(b^{\frac{1}{n}}) = \sqrt[n]{a} \sqrt[n]{b} \)

iii) \( \sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}} \); \( a \geq 0, b > 0 \)
   Why? \( \sqrt[n]{\frac{a}{b}} = \left(\frac{a}{b}\right)^{\frac{1}{n}} = \frac{a^{\frac{1}{n}}}{b^{\frac{1}{n}}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}} \)

Simplifying Expressions comprised of Radicals:
- a radical is simplified when no perfect square factor (other than 1) remains in the radicand. \( \rightarrow 4, 9, 16 \) etc.

4) Simplify \( \sqrt{20} \)

\[ \sqrt{20} = \sqrt{4 \cdot 5} = \sqrt{4} \cdot \sqrt{5} = 2\sqrt{5} \]

or, using prime factors:

\[ \sqrt{20} = \sqrt{2 \cdot 2 \cdot 5} = 2\sqrt{5} \]
eq2: Simplify $\sqrt[3]{24}$ * look for perfect cube factors 8, 27, 64, etc...

$$\sqrt[3]{24} = \sqrt[3]{8 \cdot 3} = \sqrt[3]{8} \cdot \sqrt[3]{3} = 2\sqrt[3]{3}$$

or, using prime factors:

$$\sqrt[3]{24} = \sqrt[3]{2 \cdot 2 \cdot 2 \cdot 3} = \sqrt[3]{2^3} \sqrt[3]{3}$$

eq3: Simplify $\sqrt[6]{180x^6y^3}$; $x, y \geq 0$

$$= \sqrt[6]{(5 \cdot 3 \cdot 2 \cdot 2) x^6 y^3}$$

$$= 3 \cdot 2 \sqrt[6]{5} x^3 y \sqrt[6]{y^3}$$

$$= 6x^3 y \sqrt[6]{5y^3}$$

180

90 2

45 3

15 3

eq4: Simplify $\sqrt[3]{\frac{x^{12}}{64}}$

$$= \left(\frac{x^{12}}{64}\right)^{\frac{1}{3}} = \frac{x^4}{4}$$

Changing Mixed Radicals to Entire Radicals

* the reverse of simplifying!

eq5: Write $3\sqrt{5}$ as an entire radical

$$3\sqrt{5} = \sqrt{3 \cdot 3 \cdot 5} = \sqrt{45}$$
eq 6: Write \(-4x^2\sqrt{5x^3}\); \(x \geq 0\) as an entire rad.

\[= -\sqrt{(4x^2)(4x^2)(5x^3)}\]

\[= -\sqrt{80x^7}\]

eq 7: Write \(2xy\sqrt{4x^2y^3}\); \(x, y \geq 0\) as an entire rad.

\[= \sqrt{(2xy)(2xy)(2xy)(4x^2y^3)}\]

\[= \sqrt{32x^5y^6}\]

eq 8: Write \(\frac{3x^2y}{5} \sqrt{2xy^2}\); \(x, y \geq 0\) as an entire rad.

\[= \sqrt{\left(\frac{3x^2y}{5}\right)\left(\frac{3x^2y}{5}\right)\left(\frac{3x^2y}{5}\right)(2xy^2)}\]

\[= \sqrt{\frac{54x^7y^5}{125}}\]

Hwk: Qs 1 - 16 p. 16 - 20 → Qs 9, 11, 13, 14 testable on unit test

eq 9: Find length of diagonal of a cube with side lengths of 7 units.

\[7^2 + 7^2 = x^2\]

\[98 = x^2\]

\[x^2 + 7^2 = d^2\]

\[98 + 49 = d^2\]

\[147 = d^2\]

\[d = 7\sqrt{3}\]
- The concept of "combining like terms," learned in the context of simplifying variable expressions, is also applicable when we add/subtract radicals.

- Like radicals have the same radicand and index.

**Example 1:** Simplify $\sqrt{27} + \sqrt{12} - \sqrt{8}$

*See if like radicals can be found:

\[
\begin{align*}
\sqrt{27} &= 3\sqrt{3} \\
\sqrt{12} &= 2\sqrt{3} \\
\sqrt{8} &= 2\sqrt{2}
\end{align*}
\]

\[= 3\sqrt{3} + 2\sqrt{3} - 2\sqrt{2} = 5\sqrt{3} - 2\sqrt{2}\]

**Example 2:** Simplify $\sqrt{27xy} + \sqrt{8xy}$

\[= 3\sqrt{3xy} + 2\sqrt{2xy} \quad \text{* That's it!}
\]

**Example 3:** Simplify $-3\sqrt{12} + 4\sqrt{75}$

\[= -3\cdot 2\sqrt{3} + 4\cdot 5\sqrt{3} = -6\sqrt{3} + 20\sqrt{3} = 14\sqrt{3}\]
eq4: Simplify \(4 \sqrt[3]{16} + 3 \sqrt[3]{54}\)
\[= 4 \cdot 2 \sqrt[3]{2} + 3 \cdot 3 \sqrt[3]{2}\]
\[= 8 \sqrt[3]{2} + 9 \sqrt[3]{2}\]
\[= 17 \sqrt[3]{2}\]

eq5: Simplify \(3x \sqrt{63y} - 5 \sqrt{28x^2y}\); \(x, y \geq 0\)
\[= (3x)(3)\sqrt{7y} - 5(2x)\sqrt{7y}\]
\[= 9x\sqrt{7y} - 10x\sqrt{7y}\]
\[= -x\sqrt{7y}\]

eq6: Simplify \(\sqrt{20x^2y} - 2\sqrt{45y^3}\); \(x, y \geq 0\)
\[= 2x\sqrt{5y} - (2)(3)(y)\sqrt{5y}\]
\[= 2x\sqrt{5y} - 6y\sqrt{5y}\]
\[= (2x - 6y)\sqrt{5y}\]

eq7: Simplify \(\sqrt{32x} + \sqrt{48y} - \sqrt{50x} + \sqrt{27y}\)
\[= 4\sqrt{2x} + 4\sqrt{3y} - 5\sqrt{2x} + 3\sqrt{3y}\]
\[= -\sqrt{2x} + 7\sqrt{3y}\]

eq8: Simplify \(\frac{5}{2} \sqrt[3]{16x^4y^5} - xy^3\sqrt[4]{54xy^2}\); \(x, y \geq 0\)
\[= \left(\frac{5}{2}\right)(2)(x)(y)\sqrt[3]{2xy^2} - (xy)(3)\sqrt[3]{2xy^2}\]
\[= 5xy \sqrt[3]{2xy^2} - 3xy \sqrt[3]{2xy^2}\]
\[= 2xy \sqrt[3]{2xy^2}\]
Ch. 1.5 - Multiplying and Dividing Radical Expressions

- when multiplying/dividing radical expressions, the coefficients and radicals are $\times / \div$ separately.

\[ \text{eq1: Multiply } 2\sqrt{6} \cdot 5\sqrt{3} \]
\[ = (2 \cdot 5)(\sqrt{6} \cdot \sqrt{3}) \]
\[ = 10 \sqrt{6 \cdot 3} \]
\[ = 10 \sqrt{18} \]
\[ = 10 \sqrt{9 \cdot 2} \]
\[ = 30 \sqrt{2} \]

\[ \text{eq2: Multiply } -3\sqrt{2x} \cdot 4\sqrt{3x} \; ; \; x \geq 0 \]
\[ = -12 \sqrt{6x^2} \]
\[ = -12x \sqrt{6} \]

\[ \text{eq3: Multiply } (2\sqrt{3} - 3\sqrt{2})(2\sqrt{3} + \sqrt{2}) \]
\[ \text{using FOIL} \]
\[ = 4\sqrt{9} + 2\sqrt{6} - 6\sqrt{6} - 3\sqrt{4} \]
\[ = 12 - 4\sqrt{6} - 6 \]
\[ = 6 - 4\sqrt{6} \]

\[ \text{eq4: Multiply } (\sqrt[3]{x} + \sqrt[3]{y})(\sqrt[3]{x^2} - \sqrt[3]{2xy} + \sqrt[3]{y^2}) \]
\[ \text{using distrib. meth.} \]
\[ = \sqrt[3]{x^3} - \sqrt[3]{x^2y} + \sqrt[3]{xy^2} + \sqrt[3]{x^2y} - \sqrt[3]{2xy^2} + \sqrt[3]{y^3} \]
\[ = x + y \]
Multiplying and Dividing Terms with Different Indices:

Two APPROACHES:

1. Convert all radical expressions to exponential form.
2. Use the radical property: \( \sqrt[n]{x^m} = x^{m/n} \).

\[ a \sqrt[n]{x^m} = a x^{m/n} \]

**Eq. 5:** Simplify \( \sqrt[4]{x^2} \); \( x \geq 0 \)

Method \( \text{1} \): \( (x^2)^{1/4} = x^{2/4} \)

\[ = x^{1/2} \]

\[ = \sqrt{x} \]

**Eq. 6:** Multiply \( \sqrt{x^3} \cdot \sqrt{x} \); \( x \geq 0 \)

Method \( \text{1} \): \( (x^{3/2} \cdot x^{1/2}) \)

\[ = x^{3/2} + x^{1/2} \]

\[ = x^{1.5} \]

\[ = x^{1/6} \]

\[ = \sqrt{x} \]

\[ = x \sqrt{x^5} \]

**Eq. 7:** Divide \( \frac{\sqrt{(2x-1)^4}}{\sqrt[4]{(2x-1)^3}} \); \( x > 0 \) *restriction: \( x > \frac{1}{2} \)

Method \( \text{1} \): \( \frac{(2x-1)^{4/2}}{(2x-1)^{3/4}} \)

\[ = (2x-1)^{2} \]

\[ = (2x-1)^{1/4} \]

\[ = (2x-1)^{\frac{5}{8}} \]

\[ = \frac{4(2x-1)^5}{(2x-1)} \]

\[ = (2x-1)^4 \]

**Homework:** p. 33–35 #1ab–5.
Rationalizing the Denominator
- The process of changing the denominator from an **irrational** radical number to a **rational** number.
- Never leave an answer with a radical in the denominator! *unless indicated.*

**98:** Simplify \( \sqrt{\frac{2}{7}} \)

\[
= \frac{\sqrt{2}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}} \\
= \frac{\sqrt{2 \cdot 7}}{7} \\
= \frac{\sqrt{14}}{7}
\]

**99:** Simplify \( \frac{\sqrt{2}}{y} \); \( y \neq 0 \)

\[
= \frac{\sqrt{2}}{\sqrt{y}} \cdot \frac{\sqrt{y^2}}{\sqrt{y^2}} \\
= \frac{\sqrt{2 \cdot y^2}}{y} \\
= \frac{\sqrt{2y^2}}{y}
\]

**100:** Simplify \( \frac{\sqrt{5x}}{\sqrt{10x^3}} \); \( x > 0 \)

\[
= \frac{\sqrt{5x}}{\sqrt{2x^2}} = \frac{\sqrt{\frac{5x}{2x^2}}}{x} = \frac{\sqrt{\frac{5}{2x^2}}}{x} \\
= \frac{\sqrt{\frac{5}{2x^2}}}{x} \cdot \frac{\sqrt{2x^2}}{\sqrt{2x^2}} \\
= \frac{\sqrt{10}}{x} \cdot \frac{1}{x} \\
= \frac{\sqrt{10}}{x^2}
\]

*can be simplified before rationalizing denominator!*

*Both fine.*
Using Conjugates to Rationalize a Denominator

The expressions \((a + b)\) and \((a - b)\) are called CONJUGATES.

- When conjugates are multiplied, a difference of two squares is produced, which represents a RATIONAL number.

**Example 11:** Simplify \(\frac{3}{2 - \sqrt{5}}\)

\[
\frac{3}{2 - \sqrt{5}} \cdot \frac{2 + \sqrt{5}}{2 + \sqrt{5}} = \frac{6 + 3\sqrt{5}}{4 - 5} = \frac{6 + 3\sqrt{5}}{-1} = -6 - 3\sqrt{5}
\]

\[\text{R: } -3(2 + \sqrt{5})\]

**Example 12:** Simplify \(\frac{\sqrt{x} - 2}{\sqrt{x} + 1}; \quad x \geq 0\)

\[
\frac{\sqrt{x} - 2}{\sqrt{x} + 1} \cdot \frac{\sqrt{x} - 1}{\sqrt{x} - 1} = \frac{x - 2\sqrt{x} - \sqrt{x} + 2}{x - 1}
\]

\[\text{R: } x \neq 1\]
eg 13: Simplify: \[
\frac{\sqrt{a} + \sqrt{2b}}{\sqrt{a} - \sqrt{2b}} ; \quad a, b > 0
\]

\[
= \frac{\sqrt{a} + \sqrt{2b}}{\sqrt{a} - \sqrt{2b}} \cdot \frac{(\sqrt{a} + \sqrt{2b})}{(\sqrt{a} + \sqrt{2b})}
\]

\[
= \frac{a + 2\sqrt{2ab} + 2b}{a - 2b}
\]

p. 33 - 39 # 1 c-e, 5-17
Ch. 1.6 - Radical Equations

Since it is not possible to find the square root of a negative number (within \( \mathbb{R} \)), expressions with a variable in the radicand will have restrictions.

**Example 1:** Determine the restriction on \( x \) in

\[
\sqrt{2x-3} = x-3
\]

\( 2x-3 \) cannot be negative, so...

\[
2x-3 \geq 0
\]

\[
2x \geq 3
\]

\[
\boxed{x \geq \frac{3}{2}} \\
\text{restriction}
\]

**Example 2:** Determine the restriction(s) on \( x \) in

\[
\sqrt{3x+4} - \sqrt{2x-4} = 2
\]

\[
3x+4 \geq 0 \quad 2x-4 \geq 0
\]

\[
3x \geq -4 \quad 2x \geq 4
\]

\[
x \geq \frac{-4}{3} \quad x \geq 2
\]

Both must be true

\[
\boxed{x \geq 2}
\]

**Example 3:** Determine the restriction(s) on \( x \) in

\[
\sqrt{1-x} + \sqrt{x+3} = 4
\]

\[
1-x \geq 0 \quad x+3 \geq 0
\]

\[
-x \geq -1 \quad x \geq -3
\]

\[
x \leq 1
\]

Both must be true, so...

\[
\boxed{-3 \leq x \leq 1}
\]
Solving Radical Equations
- goal is to rid the equation of radicals.
* use the principle:

If \( a = b \), then \( a^2 = b^2 \)

However, sometimes this "squaring of both sides" might introduce an **EXTRANCEOUS solution** (a solution that does NOT satisfy the original equation), you must **ALWAYS** check your answer(s)!

\( \text{Ex. 1: If } x = 3, \text{ then } x^2 = 3^2 \text{ and } x^2 = 9 \)
\[ x = \pm 3 \]
\[ x = -3 \text{ is EXTRANCEOUS.} \]

\( \text{Ex. 4: Solve } \sqrt{x+1} = x - 1 \)

Restriction? \( x \geq -1 \)

\[ (\sqrt{x+1})^2 = (x-1)^2 \]
\[ x+1 = x^2 - 2x + 1 \]
\[ 0 = x^2 - 3x \]
\[ 0 = x(x-3) \]
\[ x = 0, 3 \text{ BUT! check!} \]
\[ \text{extr. true} \]
\[ x = 3 \]
Solve \( \sqrt{3-3x} = 3 + \sqrt{3x+2} \)

\[
(\sqrt{3-3x})^2 = (3 + \sqrt{3x+2})^2
\]

\[
3 - 3x = 9 + 6\sqrt{3x+2} + (3x+2)
\]

\[
3 - 3x = 11 + 3x + 6\sqrt{3x+2}
\]

\[
\frac{-8 - 6x}{2} = \frac{6\sqrt{3x+2}}{2}
\]

\[
(-4 - 3x)^2 = (3\sqrt{3x+2})^2
\]

\[
16 + 24x + 9x^2 = 9(3x+2)
\]

\[
16 + 24x + 9x^2 = 27x + 18
\]

\[
\frac{x}{-18} = \frac{3x+2}{-3}
\]

\[
6, -3
\]

\[
9x^2 - 3x - 2 = 0
\]

\[
3x(3x+2) - 1(3x+2) = 0
\]

\[
(3x+2)(3x-1) = 0
\]

\[
x = -\frac{2}{3}, \frac{1}{3}
\]

both extraneous!

\[
x = \emptyset
\]
eq6: \[
\sqrt{2x+5} - \sqrt{x-1} = 2
\]
\[
(\sqrt{2x+5})^2 = (2 + \sqrt{x-1})^2
\]
\[
2x + 5 = 4 + 4\sqrt{x-1} + (x-1)
\]
\[
2x + 5 = 3 + x + 4\sqrt{x-1}
\]
\[
x + 2 = 4\sqrt{x-1}
\]
\[
(x+2)^2 = (4\sqrt{x-1})^2
\]
\[
x^2 + 4x + 4 = 16(x-1)
\]
\[
x^2 + 4x + 4 = 16x - 16
\]
\[
x^2 - 12x + 20 = 0
\]
\[
(x-10)(x-2) = 0
\]
\[
x = 10, 2
\]
\[
\text{check!}
\]

p. 43 - 45 #1-9
p. 283 #6

Ch. Review p. 46 - 48 #1-9