Name: Date: Period:

SQUARED: a number multiplied by itself.

Ex: 8^2 means 8 squared. To calculate, multiply 8 times 8 = 64

SQUARE ROOT (RADICAL): A number that produces a quantity when multiplied by itself. The symbol for the square root is the radical sign, $\sqrt{\#}$.

Ex: $\sqrt{9}$ = 3 because $3 \cdot 3 = 9$ $\sqrt{49}$ = 7 because $7 \cdot 7 = 49$

PERFECT SQUARE: a number made by **squaring** a whole number.

Ex: 16 is a perfect square because 4^2 is equal to 16
81 is a perfect square because 9^2 is equal to 81

CUBED ROOT: a number multiplied by itself **3** times to give you the number under the $\sqrt{\#}$.

Ex: $\sqrt[3]{8}$ = 2 because $2 \cdot 2 \cdot 2 = 8$
$\sqrt[3]{-64}$ = -8 because $(-8) \cdot (-8) \cdot (-8) = -64$

A **NON-PERFECT SQUARE** under the radical sign is an **IRRATIONAL #.**

Ex: $\sqrt{12}$ Is IRRATIONAL because 12 is not a perfect square.
$\sqrt{48}$ Is IRRATIONAL because 48 is not a perfect square.

SPECIAL NOTE: Square Root is the **OPPOSITE** operation of Squared / Cubed Root is the **OPPOSITE** operation of Cubed.

Complete the table listing the perfect squares of the numbers through 20 x 20…. the first 3 have been started for you.

#	# x itself	Perfect Square	#	# x itself	Perfect Square	#	# x itself	Perfect Square	#	# x itself	Perfect Square
1	1 x 1	1	6	6 x 6		11	11 x 11		16	16 x 16	
2	2 x 2	4	7	7 x 7		12	12 x 12		17	17 x 17	
3	3 x 3	9	8	8 x 8		13	13 x 13		18	18 x 18	
4	4 x 4		9	9 x 9		14	14 x 14		19	19 x 19	
5	5 x 5		10	10 x 10		15	15 x 15		20	20 x 20	

This is NOT a complete list of perfect squares since there are an infinite number of Perfect Squares. It is important to remember that ALL EVEN EXPONENTS are also perfect squares.

x^2 $x \cdot x$ | x^4 $x^2 \cdot x^2$ | x^6 $x^3 \cdot x^3$ | x^8 $x^4 \cdot x^4$ | x^{10} $x^5 \cdot x^5$

It is helpful to have the list of perfect squares handy when simplifying radicals. One of the most common errors is not using the LARGEST perfect square factor to simplify, then not simplifying far enough.

Estimating Radicals: To ESTIMATE a non-perfect square, find the nearest two perfect squares that it falls between. Take the square root of each and those are the two #s that the imperfect square falls between.

Example:

Estimate $\sqrt{6}$ and decide which whole # it is closer to.

Closest Perfect square less than 6 → 4 $\sqrt{6}$ 9 ← Closest perfect square greater than 6

Since the $\sqrt{4}$ = 2 and $\sqrt{9}$ = 3, $\sqrt{6}$ falls between 2 and 3. It would be closer to 2 because 4 is closer to 6 than 9 is.

Example:

Estimate $\sqrt{106}$ and decide which whole # it is closer to.

Closest Perfect square less than 106 → 100 $\quad \sqrt{106} \quad$ 121 ← Closest perfect square greater than 106

Since the $\sqrt{100}$ = 10 and $\sqrt{121}$ = 11, $\sqrt{106}$ falls between 10 and 11. It would be closer to 10 because 100 is closer to 106 than 121 is.

Estimate and decide which whole # it is closer to.

1. $\sqrt{41}$ Between _______ and _______ closer to _________
2. $\sqrt{67}$ Between _______ and _______ closer to _________
3. $\sqrt{96}$ Between _______ and _______ closer to _________
4. $\sqrt{19}$ Between _______ and _______ closer to _________
5. $\sqrt{8}$ Between _______ and _______ closer to _________
6. $\sqrt{210}$ Between _______ and _______ closer to _________

Rational or Irrational?

1. $\sqrt{4}$ Rational or Irrational
2. $\sqrt{144}$ Rational or Irrational
3. .25 Rational or Irrational
4. $\sqrt{12}$ Rational or Irrational
5. $\sqrt{81}$ Rational or Irrational
6. $\sqrt{27}$ Rational or Irrational

Simplifying Radicals: When you have a radicand that is not a perfect square, you must break it down into **simplest radical form**. To do this, separate the radicand into two factors as shown below (reminder: factors multiply to give you a product).

Parts of a radical:
coefficient$\sqrt{\text{radicand}}$

$\sqrt{\text{Non} - \text{Perfect Square}}$ → $\sqrt{\textit{Largest Perfect Square Factor}} \cdot \sqrt{\textit{Remaining Factor (cannot be simplified further)}}$

Take the square root to simplify → (Largest Perfect Square Factor)

Will remain under $\sqrt{\#}$ → (Remaining Factor)

Notes:

- **A coefficient in front gets multiplied AT THE END, once simplified.**
- **For fractions, simplify the numerator and denominator separately, then reduce, if possible.**

1. $\sqrt{18}$ $\sqrt{9}\sqrt{2}$ $3\sqrt{2}$	2. $\sqrt{40}$	3. $\sqrt{108}$	4. $3\sqrt{8}$ $3\sqrt{4}\sqrt{2}$ $3 \cdot 2\sqrt{2}$ $6\sqrt{2}$	5. $\sqrt{63x^4}$
6. $\frac{1}{4}\sqrt{48}$	7. $8\sqrt{9x}$	8. $\sqrt{\frac{4x^2}{36x}} = \frac{\sqrt{4x^2}}{\sqrt{36x}}$ $\frac{2x}{\sqrt{36}\sqrt{x}} = \frac{2x}{6\sqrt{x}}$	9. $\sqrt{49x^5}$	10. $\sqrt{\frac{50x^2}{169}}$
11. $\sqrt{0.09}$	12. $\sqrt{\frac{32}{121}}$	13. $\sqrt{\frac{18x}{49y^8}}$	14. $4\sqrt{28x^3}$	15. $\sqrt{48x^7y^3}$
16. $\sqrt{\frac{40m^3}{10n^4}}$	17. $\sqrt{36x^4y^5}$	18. $3\sqrt{24x^3y^7}$	19. $6\sqrt{32x^6y}$	20. $\sqrt{\frac{32x^5}{9y^8}}$

*Rationalizing the denominator will be taught later