**LIFEBRIDGE INTEGRATED LEARNING CENTRE**

**GRADE 8-9 MATHEMATICS EXPONENTS**

**What are exponents?**

Exponents are a short-cut way of writing something that is very useful when working with numbers. When we multiply numbers by themselves, we find some interesting results. Exponents are a shorthand way of saying how many times a number must be multiplied by itself.

e.g., 25 is a quick way of writing 2 x 2 x 2 x 2 x 2

**VERY IMPORTANT** Notice that 25 is NOT the same as 2 X 5! 25 = 32; 2 x 5 10 – quite a big difference!

**TERMINOLOGY**

This is called the **base** 34 This is called the **exponent**

Exponents are also called **powers.** 34 is called “3 to the power of 4”.

*Expanded notation*: 2 X 2 X 2 Exponential form: 23

*Evaluate*: Give the value of e.g., Evaluate 23 = 8

*Squared / square*: The power of 2 e.g., 4 squared – 42 = 16

*Cubed / cube*: The power of 3 e.g., 33 = 27

*Roots*: the numbers which when multiplied by themselves the specified number of times will yield the given amount e.g., the square root of 16 (written √16 ) is the number which equals 16 when it is multiplied by itself 2 times i.e., 4 X 4 so it is 4 another example 4√256 means the number that multiplied by itself 4 times is equal to 256 i.e., 4.

**HOW TO CALCULATE ROOTS**

e.g., Find 3√216

1. Use the “ladder method” to find the prime factors of a number

2 ׀216 2 x 2 x 2 x 3 x 3 x 3

2 ׀108 = 23 x 33

2 ׀ 54

3 ׀ 27

3 ׀ 9

3 ׀3

1. Find the cube root of each prime factor e.g., 2 X 3
2. Multiply these to reach the cube root e.g., 6
3. Check your answer by doing inverse operation: 6 x 6 = 36 X 6 = 216

**SOME IMPORTANT PRINCIPLES TO REMEMBER**

1. X0  = 1 (Any number to power of 0 = 1) Thus 240 = 1
2. X1  = X (Any number to power of 1 = that number). Thus 241 = 24
3. (x√Y)x = Y (The root of any number raised to the power of the root = that number) Thus (3√24)3 = 24.

1. When working with complex roots and exponents always follow the BODMAS rule and treat √ as a form of brackets e.g.,

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

√ 3√27 + 3 + 4 x 6

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_

=√ 9 + 3 + 4 x 6

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

=√ 9 + 3 + 24

 \_\_\_\_\_\_\_\_\_\_\_\_\_

=√ 12 + 24

 \_\_

=√36

= 6

1. (-4)2 = (-4) x (-4) = 16

-42 = - (4 x4) = -16

1. When working with exponents and roots in fractions first simplify the numerator and the denominator separately then reduce by cancelling e.g.,

2 x √16 + 3√27

 23

= 2 x 4 + 3

 8

= ~~8~~ + 3

 ~~8~~

= 1+ 3

 1

= 4

1. X½ = √X (An exponent in fraction form: the denominator is the root and the numerator is the power) e.g., 2⅔ = 3√22
2. X-3 = 1 (A negative exponent means the **inverse** of the number to that power)

 X3

 e.g., 2-3 = 1/8

9. Exponents of 10 are 1 followed by the same number of zeros as the exponent e.g., 102 = 100; 106 = 1 000 000

**LAWS OF EXPONENTS**

**LAW 1: Multiplying and dividing NUMBERS WITH THE SAME BASE**

* 1. 22 x 23  = (2 x 2) x (2 x 2 x 2) = 2 x 2 x 2 x 2 x 2 = 25  = 32

Check and see: 22  = 4, 23 = 8; 4 x 8 = 32

When **multiplying** numbers WITH THE SAME BASE we **add** the exponents.

* + 1. (a) 25 ÷ 23 = 2 x 2 x 2 x 2 x 2 = 32 = 25-3

2 x 2 x2 8

 = 2 x 2 = 4 = 22

When **dividing** numbers WITH THE SAME BASE we **subtract** the exponents.

**LAW 2: Multiplying and dividing NUMBERS WITH DIFFERENT BASES AND THE SAME EXPONENT**

* 1. 23 X 33 = 2 x 2 x 2 x 3 x 3 x 3 = 216

= (2 x 3)3 = 63 = 6 x 6 x 6 = 216

When **multiplying** numbers WITH DIFFERENT BASES AND THE SAME EXPONENT we **multiply** the bases.

1.2.1. 43 / 23 = 4 x 4 x 4 = 64 = (4)3

 2 x 2 x 2 8 2

 = 2 x 2 x 2 = 8 = 23

When **dividing** numbers WITH DIFFERENT BASES AND THE SAME EXPONENT we **divide** the bases

**LAW 3: Multiplying and dividing numbers WITH DIFFERENT BASES AND DIFFERENT EXPONENTS**

23 x 32 = 2 x 2 x 2 x 3 x 3 = 72

Numbers WITH DIFFERENT BASES AND DIFFERENT EXPONENTS cannot be multiplied or divided. They must be evaluated and then divided or multiplied or must be converted to one of the other cases and then calculated thus:

2 x 22 x 32 = 2 x 62  = 2 x 36 = 72

**LAW 4: Raising a power to another power**

Exponents inside brackets are **multiplied** with exponents outside the brackets

. (42)3 = (42) x (42) x (42) = 16 x 16 x 16 = 4096

 = 42 x 3 = 46 = 4096

**RULES FOR SQUARE AND CUBE ROOTS**

**RULE 1: Numbers multiplied inside a square root**

 \_\_\_ \_\_ \_\_\_

√ xy = √ x x √ y Can be split up into multiplication of square roots

 \_\_\_\_\_\_\_ \_\_ \_\_ \_\_\_

e.g., √ 9 x 16 = √9 x √16 = 3 x 4 = 12 OR √144 = 12

**RULE 2: Numbers divided inside a square root**

\_\_\_ \_\_

 √ x = √x

 y √y

 \_\_\_\_\_ \_\_\_

e.g., √16 = √16 = 4

 9 √9 3

**RULE 3: Numbers added or subtracted inside a square root cannot be separated**

 \_\_\_\_\_\_\_\_ \_\_ \_\_

 √ 9 + 16 ≠ √9 + √16

 \_\_\_\_\_

 √ 25 ≠ 3 + 4

 5 ≠ 7

**RULE 4: There is no solution to the square root of a negative number (but the cube root of a negative number is negative)**