**Topic C: Scientific Notation and Square Roots**

**Scientific Notation**

**Scientific notation is a special way** of concisely expressing very *large*and *small* numbers.

**Example**: 300,000,000 = 3 × 108 m/sec The speed of light.

0.00000000000000000016 = 1.6 × 10-19 C An electron.

**Scientific notation**: a product of a number between 1 and 10 and power of 10.

*N* × 10±*n*

|  |  |
| --- | --- |
| **Scientific notation** | **Example** |
| *N* × 10±*n* 1 ≤ N < 10  *n* - integer | 67504.3 = 6.75043 × 104    Standard form Scientific notation |

**Scientific vs. non-scientific notation:**

|  |  |
| --- | --- |
| **Scientific notation Not scientific notation** | |
| 7.6 × 103 | 76 × 102 76 > 10 76 is not between 1 and 10. |
| 8.2 × 1013 | 0.82 × 1014  0.82 < 1 0.82 is not between 1 and 10. |
| 5.37 × 107 | 53.7 × 106  53 > 10 53 is not between 1 and 10. |

**Writing a number in scientific notation:**

**Step Example**

* Move the decimal point ***after*** the ***first nonzero digit***. 0.00**7**9 **3**7213000.
* Determine *n* (the power of 10) by counting the *n* = 3 *n* = 7

number of places you moved the decimal.

* If the decimal point is moved to the ***right***: × 10**-*n*** 0.00**7**9 = 7.9 × 10-3

3 places to the right

* If the decimal point is moved to the ***left***: × 10***n***  **3**7213000. = 3.7213×107

7 places to the left

**Example**: Write in scientific notation.

**1)** **2340000** = 2340000. = 2.34× 106 6 places to the left, × 10*n*

**2) 0.000000439** = 4.39 × 10-7 7 places to the right, × 10*-n*

**Example**: Write in standard (or ordinary) form.

1. **6.4275 × 104** = 64275 **2)** 2.9 × 10-3 = 0.0029

**Example**: Simplify and write in scientific notation.

Multiply coefficients of 10±*n*, *aman=am+n*

18 > 10, this is not in scientific notation.

N = 1, this is in scientific notation.

Regroup coefficients of 10±*n*

*am an = am + n ,*

**Square Roots**

**Square root ():** a number with the symbol that is the opposite of the square of a number, such as and 32 = 9, respectively.

Square (32)

3 9

Square root

**Perfect square:** a number that is the exact square of a whole number.

|  |  |
| --- | --- |
| **Perfect square** | **Square root** |
| 11 = 12 = **1** | = 1 |
| 22 = 22 = **4** | = 2 |
| 33 = 32 = **9** | = 3 |
| 44 = 42 = **16** | = 4 |
| 55 = 52 = **25** |  |
| 66 = 62 = **36** | = 6 |
| 77 = 72 = **49** | = 7 |
| 88 = 82 = **64** | = 8 |
| 99 = 92 = **81** | = 9 |
| … | … |

**Examples:**

|  |  |
| --- | --- |
| **Square root** | **Square** |
| =10 | 102 = 100 |
| =7 | 72 = 49 |
| =11 | 112 = 121 |
| = 13 | 132 = 169 |
| = | 42 = 16  52 = 25 |

**Using a calculator**: = ?

 81 = (The display reads 9) Or 81 = for some calculators.

**Example:** Find the square roots.

**1)**  = = 12  144 =

**2)** = =  225 =

**Simplifying Square Roots**

**Order of operations:**

|  |  |
| --- | --- |
| **Order of operations** | |
| 1. the brackets or parentheses and absolute values  (innermost first) | ( ) , [ ] , { } , |
| 2. exponent or square root (from left-to-right) | *a****n* ,** |
| 3. multiplication or division (from left-to-right) | **×**  and  **÷** |
| 4. addition or subtraction (from left-to-right) | +and- |

**Memory aid - BEDMAS**

|  |  |  |  |
| --- | --- | --- | --- |
| **B** | **E (R)** | **D M** | **A S** |
| **B**rackets | **E**xponents or Square **R**oot | **D**ivide or **M**ultiply | **A**dd or **S**ubtract |

**Example:** Calculate.

1. **6 –**  =6 **–** 2 9 81 = 92

= 6 – 18 = -12

1. **3.22 – 3** = 10.24 – 3

10.24 – 3

= 10.24 – 9.96 = 0.28

1. = =864 = 82 = 1

**Simplifying square roots: Example**

* Factor the number inside the square root sign.

(Find the perfect square(s) that will divide the number). 25

* Rewrite the square root as a multiplication problem. =
* Reduce the perfect squares ("pulling out" the integer(s)). = 5

**Example:** Simplify.

1. = == = 3 **=**

45 4

9 5

1. = =

**Unit 11: Summary**

**Exponents, Roots & Scientific Notation**

**The degree of a term with one variable:** the exponent of its variable.

**The degree of a term with more variables:** the sum of the exponents of its variables.

**The degree of a polynomial with more variables**: the highest degree of any individual term.

**Descending order:** the exponent of a variable decreases for each succeeding term.

**Ascending order:** the exponent of a variable increases for each succeeding term.

**Properties of exponents:**

|  |  |
| --- | --- |
| **Name Rule Example** | |
| Product rule | *am* *an*= *am* + *n* 23 22 = 23 + 2 = 25 =32 |
| Quotient rule  (the same base) | (*a* ≠ 0) |
| Power of a power | (*am*)*n = amn* (*x*3)2 *= x*3*∙*2  *= x*6 |
| Power of a product  (different bases) | (*a* *b*)*n*= *an**bn*  (2 )2 = 22 32 =4 ∙9 = 36  *(a*m *b**n*)*p*= *amp**bnp* (*t*3 *s* 4)2 = *t*3∙2 *s*4∙2 = *t*6 *s*8 |
| Power of a quotient  (different bases) | (*b* ≠ 0)  (*b* ≠ 0) |
| Negative exponent | (*a* ≠ 0) |
| Zero exponent *a*0 | *a*0 = 1 150 = 1 |
| One exponent *a*1 | *a*1 = *a* (But 1n = 1)71 = 7 , 113 = 1 |

**Steps for simplifying exponential expressions:**

* Remove parentheses using “power rule” if necessary.(*a*m *b*n)p = *amp* *b*np
* Regroup coefficients and variables.
* Use “product rule” and “quotient rule”.  *am an = am + n ,*
* Simplify.
* Use “negative exponent” rule to make all exponents positive if necessary.

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**Unit 11: Self-Test**

**Exponents, Roots & Scientific Notation**

**Topic A**

1. Write the following exponential expressions in expanded form.
2. 74
3. (-*t*)3
4. (5*a*4*b*0)2
6. Write each of the following in the exponential form.
   * + 1. (0.5) (0.5) (0.5) (0.5)
       2. (6*w*) (6*w*) (6*w*)
       3. (7*u*) (3*v*) (*u*) (2*v*)
7. Evaluate.
8. 4*x*2 + 5*y*, for *x* = 1, *y* = 4
9. (2*a*)3 – 3*b*, for *a* = 5, *b* = 6
10. What is the degree of the following term / polynomial?
11. 15*ab*4
13. Arranging polynomials in descending order:

**a)**

**b)**

1. Arranging polynomials in ascending order.

**Topic B**

1. Simplify (do not leave negative exponents in the answer).
2. (-92)1
3. (-38076)0
4. (-0.4)3
5. -82
6. *y*4 *y*3
7. (*t*4)-5
8. 13*a* -1
9. [(-4) )]3
10. (3*a*2 *b*3)4

13. Evaluate for *x* = 3, *y* = 2, *z* = -2.

**Topic C**

1. Write in scientific notation.

**a)** 45,600,000

**b)** 0.00000523

1. Write in standard (or ordinary) form.

**a)** 3.578 × 103

**b)** 4.3 × 10-5

1. Simplify and write in scientific notation.

1. Simplify.