

## AP – Lesson 1

### Significant Figures and Scientific Notation

#### Part I: Significant Figures

***Significant figures:*** each of the digits of a number that are used to express it to the required degree of accuracy, starting from the first nonzero digit.

In science, all numbers are based upon measurements. Since all measurements are uncertain, we must only use those numbers that are meaningful. A common ruler cannot measure something to be 22.4072643 cm long. Not all of the digits have meaning (significance) and, therefore, should not be written down. In science, only the numbers that have significance (derived from measurement) are written.

#### **RULES FOR IDENTIFYING SIGNIFICANT FIGURES:**

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**Rule 1:** All non-zero digits are significant: 1, 2, 3, 4, 5, 6, 7, 8, 9.

**Rule 2:** Zeros between non-zero digits are significant: 102, 2005, 50009

**Rule 3:** Leading zeros are never significant: 0.02, 001.887, 0.000515.

**Rule 4:** In a number *with* a decimal point, trailing zeros (those to the right of the last non-zero digit) are significant: 2.02000, 5.400, 57.5400.

**Rule 5:** In a number *without* a decimal point, trailing zeros may or may not be significant. More information through additional graphical symbols or explicit information on errors is needed to clarify the significance of trailing zeros.

***Practice Examples:*** Identify all of the significant digits in the examples below.

0.00700	_____	10.0	_____
0.052	_____	705.001	_____
370.	_____	37,000	_____

### ADDITION AND SUBTRACTION OF SIGNIFICANT FIGURES:

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In mathematical operations involving significant figures, the answer is reported in such a way that it reflects the reliability of the least precise operation

**Step 1:** Determine the number of significant digits in each number.

**Step 2:** Add or subtract both numbers

**Step 3:** Round the answer to the LEAST number of places in the decimal portion of any number in the problem.

*Practice Examples:* Add or subtract the following

$$1.26 + 2.3 = \underline{\hspace{2cm}}$$

$$1.26 + 102.3 = \underline{\hspace{2cm}}$$

$$1.901 + 2.09 = \underline{\hspace{2cm}}$$

### MULTIPLICATION AND DIVISION OF SIGNIFICANT FIGURES:

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Remember, in mathematical operations involving significant figures, the answer is reported in such a way that it reflects the reliability of the least precise operation.

**Step 1:** Determine the number of significant digits in each number.

**Step 2:** Add or subtract both numbers

**Step 3:** Round the answer to the LEAST number of significant figures

*Practice Examples:* Multiply or divide the following

$$2.5 \times 3.42 = \underline{\hspace{2cm}}$$

$$3.10 \times 4.520 = \underline{\hspace{2cm}}$$

$$2.33 \times 6.085 \times 2.1 = \underline{\hspace{2cm}}$$

$$(4.52 \times 10^{-4}) \div (3.980 \times 10^{-6}) = \underline{\hspace{2cm}}$$

## **Part II: Scientific Notation**

Scientific Notation: is commonly used by scientists to simplify arithmetic operations. It is a way of expressing number that are too big or too small to be written in decimal form.

In scientific notation all numbers are written in the form

$$m \times 10^n$$

### **CONVERT FROM REAL NUMBER TO SCIENTIFIC NOTATION**

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**Step 1:** Move the decimal place in the number until you have a coefficient between 1 and 10.

**Step 2:** The number of places that you had to move the decimal becomes the exponent.

**Step 3:** If you moved the decimal to the right, the exponent becomes negative.

If you moved the decimal to the left, the exponent becomes positive.

Practice Examples: Convert the following real numbers to scientific notation

$$57,000,000,000,000 = \underline{\hspace{10em}}$$

$$0.000035 = \underline{\hspace{10em}}$$

### **CONVERT FROM SCIENTIFIC NOTATION TO REAL NUMBER**

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**Step 1:** Begin with the base number

**Step 2:** look at the exponent and move the decimal place by the same number to the right or left, depending if the exponent is positive or negative.

If the exponent is negative, move the decimal place to the left

If the exponent is positive, move the decimal place to the right

Practice Examples: Convert the following to real numbers

$$5.14 \times 10^5 = \underline{\hspace{10em}}$$

$$2.42 \times 10^{-7} = \underline{\hspace{10em}}$$

## MULTIPLYING AND DIVIDING NUMBERS WRITTEN IN SCIENTIFIC NOTATION

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### **Multiplication:**

**Step 1:** multiply the two coefficients

**Step 2:** multiply the two powers of ten by adding their exponents

**Step 3:** Combine your two answers and convert to scientific notation

#### **Example:**

$$\begin{aligned}(9 \times 10^{-1}) \times (3 \times 10^{10}) \\ &= (9 \times 3) \times (10^{-1} \times 10^{10}) \\ &= (27) \times (10^9) \\ &= 2.7 \times 10^{10}\end{aligned}$$

### **Division:**

**Step 1:** divide the two coefficients

**Step 2:** divide the two powers of ten by subtracting their exponents

**Step 3:** Combine your two answers and convert to scientific notation

#### **Example:**

$$\begin{aligned}(3.5 \times 10^{-6}) / (5 \times 10^{-2}) \\ &= (3.5 / 5) \times (10^{-6} / 10^{-2}) \\ &= (0.7) \times (10^{-4}) \\ &= 7 \times 10^{-5}\end{aligned}$$

## ADDING AND SUBTRACTING NUMBERS WRITTEN IN SCIENTIFIC NOTATION

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**Step 1:** if the exponents on the power of 10 are different for both numbers, change the exponent so that they are the same by either moving the decimal on the coefficient to the right or left.

**Remember...**

Moving the decimal to the left will make the number \_\_\_\_\_

Moving the decimal to the right will make the number \_\_\_\_\_

**Step 2:** Subtract or add the coefficients and put it to the power of 10 that was determined in Step 1.

**Step 3:** Move the decimal and change the exponent accordingly to ensure that there is at least one significant digit in front of the decimal place.

**Example 1:**

$$(2.9875 \times 10^{-8}) - (5.72 \times 10^{-10})$$

**Example 2:**

$$(7.58 \times 10^5) - (2.871 \times 10^6)$$

**Example 3:**

$$(4.86 \times 10^3) - (4.72 \times 10^3)$$