Nature of Science – Measurement and Scientific Tools

Vocabulary:

• Description • Explanation • International System of Units (SI)	• Scientific Notation • Percent Error

Description and Explanation:

- A **description** is a spoken or written summary of observations
- An **explanation** is an interpretation of observations
- Sharing scientific information with scientists in other parts of the world used to be difficult because they all used different units of measurement

International System of Units (SI)

- System of measurement that is internationally accepted for measurement.

The International System of Units (SI) eliminates confusion between scientists

- Most common unit used : BASE UNIT

SI Base Units		
Quantity Measured	**Unit**	**Symbol**
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric Current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	mol
Intensity of light	Candela	cd

- SI Prefixes are used to identify the size of a unit. (fraction or multiple of ten)

SI Prefixes	
Prefix	Meaning
Mega- (M)	1,000,000 (10^6)
Kilo- (k)	1,000 (10^3)
Hecto- (h)	100 (10^2)
Deka- (da)	0.1 (10^-1)
Centi- (c)	0.01 (10^-2)
Milli- (m)	0.001 (10^-3)
Micro- (µ)	0.000 001 (10^-6)

To convert SI Units, you must multiply or divide by a factor of ten.

Examples:

1. A book has a mass of 1.1kg. Find the mass of the book in grams.
   *Using the table, we can see that one kg is 1,000 times greater than 1 g. So, there are 1,000g in 1kg.

   Set up proportion:

2. A rock has a mass of 17.5 grams. Convert the measurement to kilograms.

3. A dosage of medicine is 325 mg. What is the dosage in grams?

Conversions

Kilo-

Hecto-

Deka-

UNIT

Deci-

Centi-

Mili-

(picture drawn in class)

All measurements have some uncertainty

- **Precision** is a description of how similar repeated measurements are to each other.
- **Accuracy** is a description of how close a measurement is to an accepted value.

Student Density and Error Data (Accepted value: 21.7 g/cm^3)			
	Student A	**Student B**	**Student C**
	Density	**Density**	**Density**
Trial 1	23.4 g/cm^3	18.9 g/cm^3	21.9 g/cm^3
Trial 2	23.5 g/cm^3	27.2 g/cm^3	21.4 g/cm^3
Trial 3	23.4 g/cm^3	29.1 g/cm^3	21.3 g/cm^3
Trial 4	23.4 g/cm^3	25.1 g/cm^3	21.5 g/cm^3

**Student A: most PRECISE because they are closest together

**Student C: most ACCURATE because they are closest to the accepted value

**Student B: neither precise nor accurate

Scientific Notation – a method of writing or displaying very small or very large values in a short form

**Move decimal to right or left to make a number between 1-10. Count number of decimal places moved and note the direction. Rewrite number without the extra zeros and write a multiplication symbol and number 10 with an exponent. Exponent should equal the number of places that you moved the decimal. If you moved it to the left, exponent is positive. If you moved it to the right, exponent is negative.

Examples:

149,600,000 1.49600000 = 8 places left 1.496 1.496 x 10^8	0.000000028 00000002.8 = 8 places right 2.8 2.8 x 10^-8

Let's Practice Together:

25,340,000 0.0000759

Percent Error – the expression of error as a percentage of the accepted value

- Our recorded values in an experiment are called experimental values. Each of these values will have some error.
- Percent error helps us determine the size of our experimental error.

Example: Student measures boiling point of water in the lab at 97.5 degrees Celsius. If the accepted value for the boiling point of water is 100.0 degrees Celsius, what is the percent error?

What we know: experimental value = 97.5 degrees Celsius
accepted value = 100.0 degrees Celsius

Formula: percent error = (experimental value – accepted value) divided by the accepted value, multiplied by 100%.

**write formula in class together

Let's Calculate the Percent Error together:

[(97.5 – 100.0)/100] x 100 = 2.50%

Example 2: experimental value is 18.7 and the accepted value is 19.3, find the percent error.

Scientific Tools

- ***Science Journal*** – record observations, write questions and hypotheses, collect data, analyze results
- ***Balances*** – measures the mass of an object
- ***Glassware*** – holds or measures volume of liquids
- ***Thermometers*** – measure temperature of substances
- ***Calculators*** – calculations
- ***Computers*** – electronic probes can be attached to computers to record measurements. Prepare reports and share data

Additional Tools used by Physical Scientists

- ***pH paper*** – quickly estimates the acidity of a substance
- ***Hot Plate*** – small heating device, can be placed on table
- ***Stopwatches*** – measure the time for an event to occur
- ***Spring Scale*** – measure the weight or amount of force applied to an object