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UIL SCIENCE CONCEPTS

AD Testing Services

STUDY GUIDE FOR UIL CHEMISTRY, BIOLOGY, AND PHYSICS

Contents

Periodic Table

The elements in the Periodic Table are organized in a specific order:

- Elements in a vertical column (Group) share the same number of valence electrons
    - Valence electrons are the number of un-bonded electrons in an elements outer orbital
- Elements in a horizontal row (Period) are organized based on the number of un-bonded electrons in the outer orbital
    - The number of un-bonded electrons increases from left to right
- Elements increase in atomic number and atomic mass from left to right and top to bottom
    - In the Periodic Table provided:
        - The atomic number is above the element's acronym
        - The atomic mass is below the element's acronym
    - The atomic number is based on the number of protons in each element
        - If the element is stable, the atomic number also provides the number of electrons
        - Examples: Hydrogen (H) has 1 proton/1 electron; Helium (He) has 2 protons/2 electrons; Calcium (2+) (Ca^{2+}) has 20 protons/18 electrons
    - The atomic mass is calculated based on the number of protons and neutrons in each element
        - If the atomic number and atomic mass are given, the number of neutrons can be calculated
        - Formula: Atomic Number – Atomic Mass = Number of Neutrons
        - Example
            - Hydrogen
                - Atomic number: 1
                - Atomic mass: 1
                - 1 (atomic #) – 1 (mass) = 0 (# of Neutrons)

Additional Information

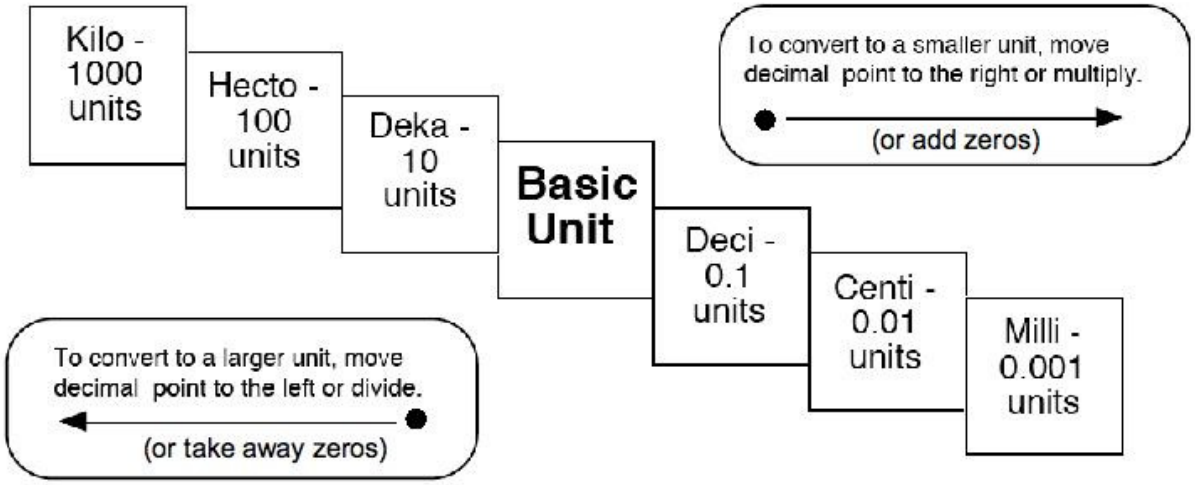
- Elements left of the "ladder" are metals
- Elements along the right side of the ladder are transitional metals
- Elements beyond the transitional metals (more right) are non-metals
- Elements in:
    - Group 18 are Noble Gases
    - Group 17 are Halogens

SCIENTIFIC UNITS OF MEASUREMENT

Metric System

- The metric system is used to measure units in all areas of science
- Temperature: degrees Celsius (℃); degrees Kelvin (K)
  - Convert Fahrenheit (℉) to Celsius (℃): subtract 32 then multiply by 5/9
  - Convert Celsius (℃) to Kelvin (K): add 273
- Length: meters (m)
- Mass: grams (g)
- Volume: liter (l)
- Time: second (s)

Metric Conversion Ladder



- Examples:
  - 1 meter = .001 kilometers or 1,000 millimeters
  - 1 kilometer = 1,000 meters or 1,000,000 millimeters
  - 1 millimeter = 1,000 meters or 1,000,000 kilometers
- Writing in scientific notation may help
  - 1,000 meters = 1×10^{3} meters
  - 0.001 meters = 1×10^{-3} meters
  - 1 meter = 1×10^{0}
- Helpful conversion phrase: **K**ing **H**enry **D**oes **D**rink **C**hocolate **M**ilk

CHEMISTRY CONCEPTS

Properties of Solutions

$$\text{Mass percent (\%) of component} = \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 100$$

$$\text{Parts per million (ppm) of component} = \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 10^6$$

$$\text{Parts per billion (ppb) of component} = \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 10^9$$

$$\text{Mole fraction on component} = \frac{\text{Moles of component}}{\text{Moles of all components}}$$

$$\text{Molarity (M)} = \frac{\text{Moles of solute (mol)}}{\text{Liters of solution (L)}}$$

$$\text{Molality (b or } m\text{)} = \frac{\text{Moles of solute (mol)}}{\text{Kilograms of solvent (kg)}}$$

Dimensional Analysis

- This involves converting one unit into another unit within the same area of measurement
    - For instance, this is how you would convert years into seconds using the dimensional analysis method

$$1 \text{ year} = \frac{365 \text{ days}}{1 \text{ year}} \quad \frac{24 \text{ hours}}{1 \text{ day}} \quad \frac{60 \text{ minutes}}{1 \text{ hour}} \quad \frac{60 \text{ seconds}}{1 \text{ minute}} \quad 31{,}536{,}000 \text{ seconds}$$

- Here's how it works:
    - Step 1: Convert your unit to the next smallest unit

$$1 \text{ year} = \frac{365 \text{ days}}{1 \text{ year}}$$

    - Step 2: Make sure your previous unit cancels with the same unit in the bottom of the conversion fraction

$$1 \text{ } \cancel{\text{year}} = \frac{365 \text{ days}}{1 \text{ } \cancel{\text{year}}}$$

    - Step 3: Continue Steps 1 and 2 until you reach the desired unit

$$1 \text{ } \cancel{\text{year}} = \frac{365 \text{ } \cancel{\text{days}}}{1 \text{ } \cancel{\text{year}}} \quad \frac{24 \text{ } \cancel{\text{hours}}}{1 \text{ } \cancel{\text{day}}} \quad \frac{60 \text{ } \cancel{\text{minutes}}}{1 \text{ } \cancel{\text{hour}}} \quad \frac{60 \text{ seconds}}{1 \text{ } \cancel{\text{minute}}}$$

    - Step 4: Check to make sure everything cancels out properly
    - Step 5: Multiply the numbers on the top
    - Step 6: Multiply the numbers on the bottom
    - Step 7: Divide the top result by the bottom result
    - Step 8: This is your converted number in the desired units

$$1 \text{ year} = \frac{365 \text{ } \cancel{\text{days}}}{1 \text{ } \cancel{\text{year}}} \quad \frac{24 \text{ } \cancel{\text{hours}}}{1 \text{ } \cancel{\text{day}}} \quad \frac{60 \text{ } \cancel{\text{minutes}}}{1 \text{ } \cancel{\text{hour}}} \quad \frac{60 \text{ seconds}}{1 \text{ } \cancel{\text{minute}}} \quad 31{,}536{,}000 \text{ seconds}$$