

2014-15

UIL SCIENCE CONCEPTS

AD Testing Services

STUDY GUIDE FOR UIL CHEMISTRY, BIOLOGY, AND PHYSICS

Contents

PERIODIC TABLE	3
SCIENTIFIC UNITS OF MEASUREMENT	4
CHEMISTRY CONCEPTS	5
PROPERTIES OF SOLUTIONS.....	5
DIMENSIONAL ANALYSIS.....	5
COMMON ELEMENTS.....	6
BONDING	7
<i>Ionic Compounds</i>	7
<i>Polyatomic ions</i>	7
<i>Criss-cross Method</i>	8
<i>Transitional Elements</i>	8
<i>Covalent Compounds</i>	8
EQUATIONS	9
TYPES OF REACTIONS.....	9
MOLES	10
MOLE CONVERSION DIAGRAM	11
STOICHIOMETRY	12
<i>Mole Ratio</i>	12
LIMITING REACTANTS	13
<i>Determining Excess Reactant</i>	14
<i>Calculating Theoretical Yield</i>	14
LEWIS STRUCTURES	15
MOLECULAR GEOMETRY	17
ELECTRON-PAIR GEOMETRIES	17
GAS LAWS	18
SOLUBILITY RULES	19
PRECIPITATES IN SOLUTION	19
<i>Colligative Properties</i>	20
EQUILIBRIUM	20
ACID/BASE.....	20
OXIDATION-REDUCTION REACTIONS.....	21
INTERMOLECULAR FORCES:	21
SPECIFIC HEAT.....	21
PHASE CHANGES.....	21
BIOLOGY CONCEPTS	22
PERSPECTIVE.....	22
CARBON.....	23
MACROMOLECULES.....	23
<i>Carbohydrates</i>	23
PROTEINS.....	26
<i>Protein Structure</i>	26
<i>Nucleic Acids</i>	27
CELLS	28
METABOLISM.....	30
<i>Enzymes</i>	30
<i>Metabolic Processes</i>	31
<i>Photoautotrophs</i>	31
CELLULAR REPRODUCTION AND DIVISION	32

GENETIC VARIATION	34
DNA/RNA	35
EVOLUTION	38
<i>Population Genetics</i>	38
<i>Hardy-Weinberg</i>	39
THE CIRCLE OF LIFE	39
<i>Non-living classifications</i>	41
<i>Prokaryotes</i>	42
<i>Germ Theory</i>	43
<i>Protists</i>	43
<i>Eukaryotes</i>	44
HUMAN PHYSIOLOGY	46
PHYSICS CONCEPTS	49
LINEAR MOTION	49
SCALAR AND VECTOR	49
DISPLACEMENT	49
UNIFORM MOTION	50
GRAPHING MOTION	50
AVERAGE VELOCITY	50
VELOCITY AT A SPECIFIC POINT	50
ACCELERATION	50
<i>Equations for Constant Uniform Acceleration in One Dimension</i>	51
<i>Equations for Free Fall Acceleration</i>	51
VECTORS	51
<i>Problems Involving Motion</i>	51
PROJECTILE MOTION	52
FORCES	52
<i>Newton's Laws of Motion</i>	53
WORK, POWER, AND ENERGY	53
ROTATIONAL MOTION	54
TEMPERATURE	55
WAVES	55
SOUND	55
LIGHT	56
ELECTRICITY	56

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 element's 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

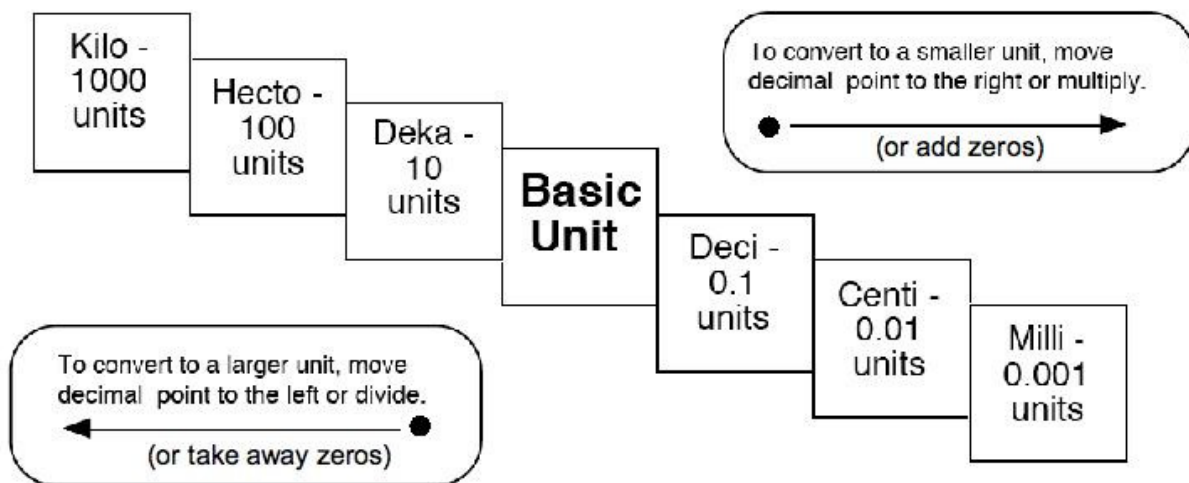
- Elements left of the “ladder” are metals
- Elements along the right side of the ladder are transitional metals
- Elements beyond the transitional metals (more right) are non-metals
- Elements in:
 - Group 18 are Noble Gases
 - Group 17 are Halogens

SCIENTIFIC UNITS OF MEASUREMENT

Metric System

- The metric system is used to measure units in all areas of science
- Temperature: degrees Celsius ($^{\circ}\text{C}$); degrees Kelvin (K)
 - Convert Fahrenheit ($^{\circ}\text{F}$) to Celsius ($^{\circ}\text{C}$): subtract 32 then multiply by $5/9$
 - Convert Celsius ($^{\circ}\text{C}$) 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: **King Henry Does Drink Chocolate Milk**

CHEMISTRY CONCEPTS

Properties of Solutions

$$\begin{aligned} \text{Mass percent (\% of component)} &= \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 100 \\ \text{Parts per million (ppm) of component} &= \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 10^6 \\ \text{Parts per billion (ppb) of component} &= \frac{\text{Mass of component in solution}}{\text{Mass of solution}} \times 10^9 \\ \text{Mole fraction on component} &= \frac{\text{Moles of component}}{\text{Moles of all components}} \\ \text{Molarity (M)} &= \frac{\text{Moles of solute (mol)}}{\text{Liters of solution (L)}} \\ \text{Molality (b or } m) &= \frac{\text{Moles of solute (mol)}}{\text{Kilograms of solvent (kg)}} \end{aligned}$$

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

$$1 \text{ year} = \frac{365 \text{ days}}{1 \text{ year}}$$
 - Step 3: Continue Steps 1 and 2 until you reach the desired unit

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