

SUMMER COURSE 2021

15th June – 15th September



In this booklet, you will find the course content detailing the key topics that students will learn in each activity.

1.0 Significant Figures

1.1 Measurements & Significant Figures

- Accuracy & precision
- Real world applications
- Introduction to significant figures
- Concept of measurement
- Resolution & uncertainty in a measurement
- Exact numbers vs measured values
- How to record a measurement

1.2 Significant Figures Rules

- Rules - zeros and non-zeros
- Expressing a quantity in different units (eg. mL to L) & s.f.

1.3 Rounding & Scientific Notation

- How to round to the appropriate number of s.f.
- How to write scientific notations with the correct number of s.f.

1.4 Significant Figures in Calculations

- Addition & subtraction
- Multiplication & division
- Logarithms

2.0 Atomic Structure

2.1 Atoms, Isotopes, Atomic Weight

- The atom
- Subatomic particles
- Coulombic forces
- Strong nuclear force
- Radioactive decay
- Isotopes
- Relative atomic mass
- Weighted average
- Atomic mass number
- Concept of weighted average & relative abundance
- Mass spectrometer
- Mass spectrum chart
- Calculate relative atomic mass & relative abundance

2.2 The Periodic Table

- Matter
- Anatomy of an atom
- Electron travels in waves
- Charge of a proton, neutron, electron
- Element vs compound
- Mendeleev's periodic table
- The modern periodic table & its arrangement
- How to read the periodic table
- Atomic number
- Derive #neutrons using atomic mass and atomic number
- What are valence electrons
- Element families
- How to use the periodic table to obtain the #valence electrons for each element
- Groups & periods
- Electronegativity
- Ionic, covalent (polar and non-polar) bonds
- Study the properties of each group of elements on the periodic table
- Reactivity of elements
- Diatomic elements

2.3 Electron Configurations

- Electron cloud
- Atomic orbitals
- The periodic table block (s,p,d,f)
- How to write electron configuration, shorthand and longhand
- Electron configuration of an ion
- Excited and ground state electron configuration

2.4 Periodic Trends

- Dimitri Mendeleev periodic table vs the modern periodic table
- Effective nuclear charge (Z_{eff})
- Calculate (Z_{eff}) using an approximate method ($Z_{\text{eff}} = z - s$)
- Discover the trend of (Z_{eff}) across/down a period
- How to use Coulomb's law to explain periodic trends
- Electronegativity
- How does nuclear charge affect electronegativity
- Ionization energy
- 1st & 2nd ionization energy
- Factors affecting ionization energy
- Shielding
- Ionic radius
- Ionization energy trend & exceptions
- Electron affinity & exceptions

2.5 Naming Compounds

- Flowchart for naming compounds
- Common chemical names
- Periodic table organization - metals, semimetals, non-metals
- Ionic & covalent compounds - simple categorization (metal + metal & metal & non-metal)
- What are binary compounds
- Ionic vs covalent bonds using electronegativity & Pauling scale, & exceptions

- Naming covalent compounds rules
- Naming ionic compounds rules
- Ionic charges - periodic table
- Balance charges
- Naming compounds with transition elements using Roman numerals

2.6 Polyatomic Ions

- What are polyatomic ions?
- Compounds containing polyatomic ions
- Learn the format - hypo_ite, _ite, _ate, per_ate
- Memorize names and charges
- Acids with polyatomic ions
- More complex polyatomic ion compounds

3.0 Lab

3.1 Flame Test Lab

- Objective of flame test lab
- Real life applications
- The quantization of energy
- Energy levels
- Ground state, excited state
- Wavelength
- Photon, Absorption, Emission
- Visible spectrum
- Wavelength (short vs long)
- Speed of light, energy of light
- Lab safety
- Equipment & materials
- How to operate the bunsen burner
- How to clean the nichrome wire
- Carry out the flame test (video simulation) & record observations
- Identify the unknown metals in the solutions
- Post lab questions

4.0 Stoichiometry

4.1 Mole & Molar Mass

- Molar mass of elements, compounds, hydrates

4.2 Balancing Equations

- Introduction to stoichiometry
- Types of reactions & law of conservation of mass
- Learn to count atoms
- Balancing simple equations

4.3 Balancing Complex Equations

- Balance complex equations with polyatomic ions

4.4 Stoichiometry

- How to express quantities correctly
- Conversion factors
- Ratio and proportion
- Use of dimensional analysis table
- Convert moles to moles
- Convert mass to moles
- Multistep stoichiometry problems

4.5 Empirical Formula & Percent Composition

- Real life applications of empirical formula

- Difference between empirical formula & molecular formula
- Convert molecular formula to empirical formula
- Law of definite proportions
- Percent composition using mass
- Combustion analysis
- Using combustion analysis and mass spectrometer to identify unknown compound

4.6 Limiting Reactant & Percent Yield

- Brief introduction to where limiting reactant concept is used
- Method #1 - moles/coeff
- Method #2 - assume each reactant is the limiting reactant & calculate maximum amount that would be produced
- Calculate amount of excess reactant
- Calculate percent yield

4.7 Solutions & Dilutions

- Aqueous solutions (aq)
- Homogeneous solution
- Solute and solvent
- Ideal and non-ideal solutions
- Molarity
- $M_1V_1 = M_2V_2$
- Stock solutions
- How to perform dilutions using volumetric flasks
- Ion concentrations