

# CHEMISTRY PLACEMENT TEST ELIGIBILITY FOR CHEM 161

(Revised 11/28/2016)

## What is the Chemistry Placement Test?

The Chemistry Placement Test is an exemption exam to determine whether a student is eligible to waive CHEM 139 and enroll directly into CHEM 161 at Seattle Central College.

This test is not transferable to other colleges, and is not accepted at the North and South campuses.

**Please be aware that this test does not grant credit for CHEM 139, but only proves that you do not need to take it before enrolling in CHEM 161.**

## TEST INFORMATION

COST & ID:	FREE, and Photo ID is required.
TIME LIMIT:	2 HOURS, must be taken in one session
FORMAT:	Paper-and-pencil, multiple-choice 5 modules, worth 20 points each
PASSING SCORE:	15 points or more in <u>all five</u> modules
RETAKE:	90 day waiting period before retaking.
VALID FOR:	3 years, at Seattle Central.
MATERIALS:	Periodic table, logarithm chart, scratch paper, pencils, and scientific calculator will all be provided. Non-native English speakers may bring a dictionary.  Electronic devices, other than electronic dictionaries, are not allowed. Cell phones are strictly prohibited.
RESULTS:	Usually within 10-15 minutes.
TEST TIMES:	Walk-in only, no appointments. Check test schedule: can vary by quarter.
STUDY GUIDE:	Attached guide created by Science and Math Dept (SAM 110, 206-934-3858).

# SCC Chemistry

## Review for Placement Exam by Topic

highlighted areas within a given topic are the focus items that are testable

**Suggested Text: Zumdahl S. S.; DeCoste, D. J. "Introductory Chemistry", 8<sup>th</sup> Edition, Cengage, 2014  
(earlier versions are fine as well)**

### **Matter & Energy, General Principles (chapters 3 & 10)**

- Classification of Matter: Mixtures (Homogeneous and Heterogeneous) and Pure Substances (Compounds and Elements)
- Physical and Chemical Properties of Matter
- Electrostatics
- The Laws of Conservation of Mass and Energy
- Energy: Potential and Kinetic and Thermal (something that has energy has the capacity to do work)
- Transfer of Energy by Work and Heat
- Exothermic-chemical system loses heat to the surroundings
- Endothermic-chemical system gains energy from the surroundings

### **Uncertainty (chapter 2)**

- Accuracy vs. Precision
- Significant Figures in Calculations and Measurements
- Metric Prefixes
- Unit or Dimensional Analysis

### **Matter, General Atomic Theory (chapter 4)**

- The Law of Definite Proportion (or Constant Composition)-originally based on mass ratio not atomic ratio
- Dalton's Theory of the Atom
- The Law of Multiple Proportions-predicted by Dalton's Theory
- The Nuclear Atom: knowledge of constituent particle (charge): proton (+), electron (-), neutron (0)
- Isotopes (Neutral): Atomic Number, Mass Number, Symbol
- Weighted Average Mass
- Ions: Cations (+, less electrons than protons) & Anions (-, more electrons than protons)
- The Periodic Table: Groups and Periods;  
metals, non-metals, metalloids, alkali metals, alkaline earth metals, chalcogens, halogens, noble gases

### **Matter, Electron Organization in Atoms based on Quantized Energy (chapter 11)**

- Electrons have both wave characteristics (electrons can be diffracted by crystals) and particle characteristics (electrons have mass and momentum)
- Light (electromagnetic radiation) has both wave characteristics (waves can be diffracted by crystals) and particle characteristics (photons have momentum, but no mass)
- Emission spectra of elements demonstrate that the energy of electrons is quantized-discrete bands of light relate directly to discrete jumps of electrons from high energy to low energy.
- The Bohr Model of the Nuclear Atom (works only for the H atom and 1 electron ions)
- Traveling waves transfer energy, standing waves store energy
- If electrons have wave characteristics and their energy is quantized then electrons can be described as standing waves having discrete amounts of energy.
- The Energy is stored until the electron absorbs a photon of particular energy OR until the electron emits a photon of particular energy.
- Absorption or Emission results in the electron moving to a new energy level.
- The Heisenberg Uncertainty Principle: knowing both the position and speed (momentum) very accurately at the same time is not possible with small objects such as electrons, because the light used to measure one quantity adds significant uncertainty to the other quantity.
- Quantum Mechanics allows for the construction of 3D regions of space where particular electrons are likely to be found; these regions are called orbitals (a solution for the energy/position of an electron in an atom is a wavefunction ( $\Psi$ )). There are many solutions for an electron's energy/position. These solutions are called orbitals).

- $\Psi^2$  (The Electron Probability Density) is more physically comprehensible than  $\Psi$ : This allows us to see where the electron density at a given point is the greatest OR where we are most likely to find an electron of a particular energy around its nucleus.

-Know the shapes of the s, p, and d orbitals

-The Principle Quantum Numbers: n, l, m<sub>l</sub>, m<sub>s</sub>

-Electron Configurations for Groundstate Atoms or Ions (longhand and core notations)

-Orbital Energy Filling Diagrams for Groundstate Atoms or Ions

-The *Periodic Law* refers to the recurrence of certain physical and chemical properties when elements are ordered by increasing atomic number. The periodicity of properties for elements of the same family is based on those elements having a similar number of valence electrons.

-*Periodic Trends* for a set of elements in a period or group-Ionization Energy (IE), Atomic Radius (AR), and Electronegativity (EN)-can be explained by discussing the attraction of electrons in atoms as one goes across and down the periodic table.

## **Bonding Concepts (chapter 12)**

### Ionic Bond Formation

- electron transfer creates cation and anion, typified, but not exclusively, by the reaction of a metal and a non-metal
- charged species, cation and anion, have noble-gas electron configurations
- despite separation of charge, the force of attraction between cation and anion stabilizes the ions
- basic nomenclature includes binary type I and II

### Covalent Bond Formation

- involves cooperative attraction of a pair of electrons between the nuclei of two atoms
- each atom in bond achieves a noble gas electron configuration
- stabilization of bonded atoms occurs because the mutual attraction of bonding electrons just overcomes repulsion between electrons and that between protons.
- basic nomenclature is binary type III

### Metallic Bonding

- delocalization of electrons explains conductivity and other properties of metals
- "sea of electrons" in collection of atoms

### Lewis Dot Diagrams (Ionic & Covalent)

- application of quantum mechanics (electron configurations and valence electrons) for the elucidation of structure
- a paired electron model (a primary consideration)
- duet rule for H and Li (atom achieves a configuration like He), octet rule for all other atoms not including exceptions listed below (atom achieves a noble gas like configuration, not including He)
- Key features: all valence electrons counted with adjustment if species is charged, duet and octet rules satisfied
- resonance structures imply delocalization of electrons but are not true structures (remember the resonance arrow:

↔)

- exceptions to the octet rule (B, P, S)

### Assessment of Bond Polarity and Molecular Polarity

- use of electronegativity values or trends to determine an electronegativity difference between two atoms
- depiction of polarity: use of dipole moments and partial charges
- VSEPR Geometry of molecules and ions: Linear, Trigonal Planar, Bent, Tetrahedral, Trigonal Pyramidal
- polarity of molecules: combination of Lewis Structure, VSEPR model and bond polarity

## Nomenclature (Naming) (chapter 5)

- Strong naming knowledge will allow for quick translation of equations from words to symbols or symbols to words.
- Naming Binary Compounds (I, II, III)
- polyatomic ions: halooxy anions (perchlorate, chlorate, chlorite, hypochlorite), oxy ions (sulfate/sulfite, phosphate/phosphite, nitrate/nitrite, permanganate, chromate, dichromate, carbonate), acetate, ammonium, cyanide, hydride, hydroxide, peroxide
- acids: made from halooxy and oxy ions and acetate, binary acids (eg. HCl, H<sub>2</sub>S, etc.)
- DO NOT MEMORIZE common transition metal charges since you will always be able to infer the charge from the anion, i.e. MnO<sub>2</sub>: X<sub>Mn</sub> + (2 x 2-) = 0, therefore X = Mn = 4+

## Reactions: Balancing and Characterization (chapters 6, 7, 18)

### Balancing Equations

### Types of Reactions

General Terms: electron transfer, proton transfer, or metathesis

Specific Terms:

- oxidation reduction, redox
- synthesis
- decomposition
- single replacement (always redox), use an metal activity table to predict reactivity
- double replacement (precipitation and neutralization, never redox), use a solubility table to predict reactivity
- combustion, typically for organic compounds (C<sub>w</sub>H<sub>x</sub>N<sub>y</sub>O<sub>z</sub>), but not exclusively, reacting with O<sub>2</sub>, although not exclusively.
- Writing net ionic equations single replacement and double replacement (precipitation & neutralization) reactions
- Weak vs. Strong for acids and bases
- Oxidation States
- Half-Reaction Method for balancing redox equations

## Molar Mass (chapter 8)

- formula molar mass calculations for compounds
- the mole and mass/mole conversions
- % Composition (remember this is percent by mass not by mole)
- empirical and molecular formula determination (use of mass measurements to obtain the most basic representation of a compounds structure-its formula!)

## Stoichiometry (chapter 9)

Basic stoichiometric calculations using mass/mole conversions, Limiting Reactant, % Yield

## Solution Chemistry (chapter 15)

- terminology (solute, Solvent, solution)
- formation: What interactions change when a solute dissolves?
- the concept of equilibrium in the development of a saturated solution
- factors affecting solubility: can you explain to someone why the following affect solubility?

“like dissolves like” - when intermolecular forces between solvent particles, between solute particles, and between solute-solvent particles are similar, dissolving generally occurs. Remember, oil does mix with water but not to a great extent since the attraction of oil to oil and that of water to water are together greater than the attraction between oil and water. It's a TRADEOFF. How much energy goes in, how much comes out? If energy is released (more produced than used), mixing generally occurs.

temperature-be careful, since some ionic compounds become less soluble at higher temperature and gases typically have lower solubility at high temperature. Think Rock Candy!

partial pressure of solute gas over liquid solution-pressure is generally not an issue for the solubility of solids or liquids. The partial pressure of the solute gas will not be affected by the presence of different gases. Think SODA POP! What if you take a can of soda and shake it, heat it, open it?

Molarity (mol solute/ L of solution)

% by mass (g of solute/g of solution)

Dilution:  $M_1V_1 = M_2V_2$

Solution Stoichiometry: applied to double replacement, redox, and neutralization reactions

## Acids and Bases (chapter 16)

-Arrhenius and Brønsted-Lowry acid-base definitions

-Strong vs. Weak Acids and Bases, review

$[H_3O^+]$   $\equiv$  concentration of  $H_3O^+$  in the unit Molarity

$pH = -\log[H^+] = -\log[H_3O^+]$

$pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH > 7$  basic

$pH < 7$  acidic

$[H_3O^+] = 10^{-pH}$