Richmond Public Schools
Department of Curriculum and Instruction
Curriculum Pacing and Resource Guide – Unit Plan

Course Title/ Course #: EOC Chemistry/2802 or EOC Pre AP Chemistry/ 2804

Unit Title/ Marking Period # (MP):1

Start day: Day 28

Meetings (Length of Unit): 3 Weeks

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

CH.2a-c,g,i

CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of
a) average atomic mass, mass number, and atomic number;
b) isotopes, half lives, and radioactive decay;
c) mass and charge characteristics of subatomic particles;
g) electron configurations, valence electrons, and oxidation numbers;
i) historical and quantum models.

Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:

- The periodic table is arranged in order of increasing atomic numbers.
- The atomic number of an element is the same as the number of protons. In a neutral atom, the number of electrons is the same as the number of protons. All atoms of an element have the same number of protons.
- The average atomic mass for each element is the weighted average of that element's naturally occurring isotopes.
- The mass number of an element is the sum of the number of protons and neutrons. It is different for each element's isotopes.
- An isotope is an atom that has the same number of protons as another atom of the same element but has a different number of neutrons. Some isotopes are radioactive; many are not.
- Half-life is the length of time required for half of a given sample of a radioactive isotope to decay.
- Electrons have little mass and a negative (–) charge. They are located in electron clouds or probability clouds outside the nucleus.
- Protons have a positive (+) charge. Neutrons have no charge. Protons and neutrons are located in the nucleus of the atom and comprise most of its mass. Quarks are also located in the nucleus of the atom.
- Discoveries and insights related to the atom's structure have changed the model of the atom over time. Historical models have included solid sphere, plum pudding, nuclear, and planetary models. The modern atomic theory is called the quantum mechanical model.
- Electron configuration is the arrangement of electrons around the nucleus of an atom based on their energy level.

- Electrons are added one at a time to the lowest energy levels first (Aufbau Principle). Electrons occupy equal-energy orbitals so that a maximum number of unpaired electrons results (Hund's Rule).
- Energy levels are designated 1–7. Orbitals are designated s, p, d, and f according to their shapes and relate to the regions of the Periodic Table. An orbital can hold a maximum of two electrons (Pauli Exclusion Principle).
- Atoms can gain, lose, or share electrons within the outer energy level.
- Loss of electrons from neutral atoms results in the formation of an ion with a positive charge (cation). Gain of electrons by a neutral atom results in the formation of an ion with a negative charge (anion).
- Transition metals can have multiple oxidation states.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- determine the atomic number, atomic mass, the number of protons, and the number of electrons of any atom of a particular element using a periodic table.
- determine the number of neutrons in an isotope given its mass number.
- perform calculations to determine the "weighted" average atomic mass.
- perform calculations involving the half-life of a radioactive substance.
- differentiate between alpha, beta, and gamma radiation with respect to penetrating power, shielding, and composition.
- differentiate between the major atom components (proton, neutron and electron) in terms of location, size, and charge.
- identify key contributions of principal scientists including:

- atomos, initial idea of atom – Democritus
- first atomic theory of matter, solid sphere model – John Dalton
- discovery of the electron using the cathode ray tube experiment, plum pudding model – J. J. Thomson
- discovery of the nucleus using the gold foil experiment, nuclear model – Ernest Rutherford
- discovery of charge of electron using the oil drop- Robert Millikan
- energy levels, planetary model – Niels Bohr
- periodic table arranged by atomic mass – Dmitri Mendeleev
- periodic table arranged by atomic number – Henry Moseley
- quantum nature of energy – Max Planck
- uncertainty principle, quantum mechanical model – Werner Heisenberg
- wave theory, quantum mechanical model – Louis de Broglie.

- relate the position of an element on the periodic table to its electron configuration.
- determine the number of valence electrons and possible oxidation numbers from an element's electron configuration.
- write the electron configuration for the first 20 elements of the periodic table.
- differentiate between the historical and quantum models

Vocabulary

half-life	periodic table	Electron volt	atomic mass	Gamma radiation
nuclear radii	atom	Energy level	Absorption spectrum	shielding
historical models	atomic theory	ion	Bohr model	composition
quantum models	electron	nucleus	element	Laser
isotopes	cathode ray	atomic number	radioactive	Orbital
nuclear particles	proton	mass number	Alpha radiation	energy level
Photon	neutron	atomic mass unit	Beta radiation	valence electrons
electron dot diagram	Atomic radius	Aufbau principle	Electron configuration	Shell
Period	Pauli exclusion principle	Chemical family	Hund's rule	Spin
		Diagonal rule	Orbital	Subshell

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

Evidence of Mastery: Students will display mastery by consistently scoring at a "C" or above range on all assessments. Success and mastery will also be shown by increasing scores from the beginning of the unit to the end of the unit. Overall mastery of the content and successful learning of the Targeted Objectives will be measured by assessing the Lab Journal for the Atomic Structure Lab and the final unit assessment. Mastery will result in score 90 out of 100 points on the Atomic Structure Lab Rubric and the final assessment scores at or above "C".

Other Assessment Methods

- Group Discussions
- Student Reports
- Teacher-Created IA Test/Quiz
- Writing Assignment

Possible Learning Gaps

- Only one model of the atom is correct.
- The electrons in an atom orbit its nucleus like planets in our solar system orbit the sun.
- Electron clouds are pictures of electrons in their orbits.
- The electron cloud is like a rain cloud, with electrons inside of it like drops of water.
- An electron cloud has electrons in it, but the cloud itself is made of some other material.
- Hydrogen is a typical atom.
- Electrons are larger than protons.
- Electrons and protons are the only fundamental particles.
- The current model of the atom is the right model.
- Atoms can disappear after time.
- Atoms are microscopic versions of elements—hard or soft, liquid or gas, and so forth.
- Atoms can be seen with a microscope.
- Atoms move, so they are alive.
- An electron shell is hard, like an eggshell.
- Atoms “own” the electrons in their orbits.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

Flame tests

When heated, any element will release light in specific colors called an emission spectrum. An emission spectrum will be the exact opposite of the absorption spectrum illustrated in the Bohr Model: Introduction Gizmo. You can observe emission spectra by heating substances in the flame of a lab burner. First, obtain a variety of salts such as sodium chloride (NaCl), lithium chloride (LiCl), potassium chloride (KCl), calcium chloride (CaCl2), barium chloride (BaCl2), copper sulfate (CuSO4), and lead nitrate (Pb(NO3)2). You also will need a Bunsen burner, clean wire loops, and student spectroscopes. To perform a flame test, first light the Bunsen burner. Dip a wire loop in water and then in the test substance. Place the wire over the hottest part of the flame to see a bright color. Have students observe each flame both with the naked eye and through a spectroscope.

Scientist Research Project

Atoms are too tiny to see, yet much about their structure had been deduced by the early part of the twentieth century. The development of atomic theory is one of the central narratives of physics and well worth learning more about. Divide the class into groups and assign to each group one of the critical scientists involved in atomic theory. These could include Democritus, John Dalton, Dmitri Mendeleev, J.J. Thomson, Robert Millikan, Ernest Rutherford, Marie Curie, James Chadwick, Niels Bohr, Enrico Fermi, and others (see **Selected Web Resources**). After researching their scientist via the Internet, students can present their findings with posters, atom models, and even reenactments of famous experiments.

Atom models

Have your students build atom models. To make an atom model, use a compass to draw 4 concentric circles on a sheet of white construction paper or cardstock. Cut out circles of colored construction paper to represent protons, neutrons, and electrons. (You can also use felt, cotton balls, or plastic disks for the particles.) On the three outer rings, draw empty circles in pairs to represent where electrons can be placed: 2 circles on the inner ring, 8 on the second, and 8 on the outermost ring. Once students have constructed their models, they can model atoms of any element in the first three rows of the periodic table. Give the name of the element, the atomic number, and the mass number. Once students have placed the correct number of protons, neutrons, and electrons on their model, they can draw an electron dot diagram for that element. Students can also make ions with their model. To make a positively charged ion, remove electrons from the neutral atom. To make a negatively-charged ion, add electrons. The same atom models will come in handy when you discuss chemical bonding. You can model an ionic bond by removing electrons from one model and adding them to another. For example, an electron can be removed from a sodium model and added to a fluorine model. This results in two ions that each have stable sets of 8 valence electrons. The positively charged sodium ion attracts the negatively charged fluorine atom, and an ionic bond forms. Covalent bonds can be demonstrated with these models as well.

Hog Hilton – Electron Configuration
Students become the manager of a prestigious new hotel in downtown Milwaukee " Hog Hilton". They are tasked with fill rooms in the hotel. They must fill up your hotel keeping the following rules in mind:

1. Hogs are lazy and want the best accommodations possible without having to expend energy (they don't want to climb steps). (Aufbau Principle)
2. Hogs can't stand each other except when rule #1 forces them to put up with each other. (Hund's Rule).
3. If hogs are in the same room they will face in opposite directions.
4. They stink, so you can't put more than two hogs in each room. (Pauli Exclusion Principle).

Atomic Structure Magic Square

POGIL Activities
Atoms and Their Isotopes
Analysis of Spectral Lines Lewis Dot Structures of Atoms and Ions
Nuclear Fission and Fusion
Nuclear Reaction Equations

Labs
Growing Crystals – Use this website to help demonstrate and experiment with growing different crystals using various elements.
Experiments with Ammonia – This experiment educates students about ammonia and its properties.
Enzyme Chemistry – Learn more about how the enzymes in food create a chemical reaction that breaks down protein.
Atomic Structure Lab II

Technology Integrations

Gizmos	**PhET Simulations:**
Element Builder	Build an Atom
Bohr Model: Introduction	Radioactive Dating Game
Bohr Model of Hydrogen	Radio Waves & Electromagnetic Fields
Electron Configuration	Alpha Decay
	Beta Decay
	Nuclear Fission
	Balloons & Static Electricity

	Blackbody Spectrum Isotopes & Atomic Mass Models of the Hydrogen Atom Neon Lights & Other Discharge Lamps Rutherford Scattering

Resources

VDOE Lesson Plans Radioactive Decay and Half-Life (PDF) / (Word) Isotopes (PDF) / (Word) Elements and Electron Configuration (PDF) / (Word) Atomic Structure: Elements (PDF) / (Word) Average Atomic Masses (PDF) / (Word) **Review Power Point:** Atomic Structure Atomic Structure II Nuclear Chemistry The Hydrogen Bomb The Dual Nature of the Electron Electrons in Atoms Hog Hilton – Electron Configuration Activity	**Videos** What are Atoms? Atomic # & Atomic Mass Atomic Mass Calculating Relative Atomic Mass Drawing Electron Configuration Diagrams Energy Levels What is a weighted average? **Selected Web Resources** Physics 2000 Spectral lines Elements as atoms The quantum atom: What is spectroscopy? Matter History of atomic theory Rutherford Rutherford II Mr. Christopherson's Website

Cross Curricular Connection

English: Journalists often write about "scientific proof" and some scientists talk about it, but in fact, the concept of proof — real, absolute proof — is not particularly scientific. Science is based on the principle that any idea, no matter how widely accepted today, could be overturned tomorrow if the evidence warranted it. Science accepts or rejects ideas based on the evidence; it does not prove or disprove them. To learn more about this, visit our page describing how science aims to build knowledge.

Math: Calculating mean, median & mode.

Real World: Use everyday ideas to introduce the terms and promote discussion:
– Accuracy and precision are required to succeed at darts and archery.
– A cookery book must contain recipes that are repeatable and reproducible, otherwise no one would want to buy it.