

**Pennsylvania High School Science
Academic Standards for Science and Technology and Engineering Education 2009**

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Physical Science	Boardworks High School Chemistry Presentation
3.2. Physical Sciences: Chemistry and Physics	
3.2.A. Chemistry	
3.2.C.A1. Properties of Matter	
<i>Differentiate between physical properties and chemical properties.</i>	–
<i>Differentiate between pure substances and mixtures; differentiate between heterogeneous and homogeneous mixtures.</i>	–
Explain the relationship of an element's position on the periodic table to its atomic number, ionization energy, electro-negativity, atomic size, and classification of elements.	Electron Structure and the Periodic Table Electronegativity Ionization Energy The Periodic Table
Use electro-negativity to explain the difference between polar and nonpolar covalent bonds.	Electronegativity
3.2.10.A1. Grade 10	
Predict properties of elements using trends of the periodic table.	Electron Structure and the Periodic Table The Periodic Table
<i>Identify properties of matter that depend on sample size.</i>	–
Explain the unique properties of water (polarity, high boiling point, forms hydrogen bonds, high specific heat) that support life on Earth.	Water
3.2.12.A1. Grade 12	
Compare and contrast colligative properties of mixtures.	–
Compare and contrast the unique properties of water to other liquids.	Water
3.2.C.A2. Structures of Matter	
Compare the electron configurations for the first twenty elements of the periodic table.	Electron Configuration
Relate the position of an element on the periodic table to its electron configuration and compare its reactivity to the reactivity of other elements in the table.	Electron Structure and the Periodic Table Patterns of Behavior The Periodic Table
Explain how atoms combine to form compounds through both ionic and covalent bonding.	Covalent Bonding Ionic Bonding Why do Atoms Form Bonds?
Predict chemical formulas based on the number of valence electrons.	Electron Structure and the Periodic Table
<i>Draw Lewis dot structures for simple molecules and ionic compounds.</i>	–
Predict the chemical formulas for simple ionic and molecular compounds.	Covalent Bonding Ionic Bonding

Use the mole concept to determine number of particles and molar mass for elements and compounds.	Gases and Moles Molar Mass What are Moles?
Determine percent compositions, empirical formulas, and molecular formulas.	Percentage Composition by Mass Types of Formulae
3.2.10.A2. Grade 10	
Compare and contrast different bond types that result in the formation of molecules and compounds.	Covalent Bonding Giant Covalent Structures Ionic Bonding Ionic Compounds
Explain why compounds are composed of integer ratios of elements.	Relative Formula Mass
3.2.12.A2. Grade 12	
Distinguish among the isotopic forms of elements.	Isotopes
Explain the probabilistic nature of radioactive decay based on subatomic rearrangement in the atomic nucleus.	Radioactivity
Explain how light is absorbed or emitted by electron orbital transitions.	Observing Line Spectra
3.2.C.A3.Matter & Energy	
Describe the three normal states of matter in terms of energy, particle motion, and phase transitions.	Changing State Particles in Action
Identify the three main types of radioactive decay and compare their properties.	Radioactivity Types of Radiation
Describe the process of radioactive decay by using nuclear equations and explain the concept of half-life for an isotope.	Half-Life Types of Radiation
Compare and contrast nuclear fission and nuclear fusion.	Nuclear Fission Nuclear Fusion
3.2.10.A3. Grade 10	
<i>Describe phases of matter according to the kinetic molecular theory.</i>	–
3.2.12.A3. Grade 12	
<i>Explain how matter is transformed into energy in nuclear reactions according to the equation $E=mc^2$.</i>	–
3.2.C.A4. Reactions	
<i>Predict how combinations of substances can result in physical and/or chemical changes.</i>	–
Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.	Conservation of Mass Relative Formula Mass
Balance chemical equations by applying the laws of conservation of mass.	Reacting Masses

Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combustion.	Combustion Neutralization Redox Reactions
Use stoichiometry to predict quantitative relationships in a chemical reaction.	Reacting Masses Yield and Atom Economy
3.2.10.A4. Grade 10	
Describe chemical reactions in terms of atomic rearrangement and/or electron transfer.	Reacting Masses
Predict the amounts of products and reactants in a chemical reaction using mole relationships.	What are Moles?
Explain the difference between endothermic and exothermic reactions.	Endothermic Reactions Exothermic Reactions
Identify the factors that affect the rates of reactions.	Concentration, Pressure and Reaction Rates Rates of Reaction Surface Area, Catalysts and Reaction Rates Temperature and Reaction Rates
3.2.12.A4. Grade 12	
Apply oxidation/reduction principles to electrochemical reactions.	Redox Reactions
Describe the interactions between acids and bases.	pH and Indicators Properties of Acids and Alkalis
3.2.C.A5 Unifying Themes	
MODELS	
Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom), and understand how each discovery leads to modern theory.	Introducing Atoms
Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.	Introducing Atoms

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Grade 10	
A. Explain concepts about the structure and properties of matter.	
Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable.	Atomic Structure Introducing Atoms
Explain the repeating pattern of chemical properties by using the repeating patterns of atomic structure within the periodic table.	Electron Structure and the Periodic Table Patterns of Behavior The Periodic Table
Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations.	Ideal Gas Laws
Describe phases of matter according to the Kinetic Molecular Theory.	Changing State Particles in Action
Explain the formation of compounds and their resulting properties using bonding theories (ionic and covalent).	Comparing Bonding Covalent Bonding Giant Covalent Structures Ionic Bonding Ionic Compounds Why do Atoms form Bonds?
Recognize formulas for simple inorganic compounds.	Naming Compounds
Describe various types of chemical reactions by applying the laws of conservation of mass and energy.	Conservation of Mass
Apply knowledge of mixtures to appropriate separation techniques.	Separating Mixtures
Understand that carbon can form several types of compounds.	Naming Compounds
B. Analyze energy sources and transfers of heat.	
<i>Determine the efficiency of chemical systems by applying mathematical formulas.</i>	–
<i>Use knowledge of chemical reactions to generate an electrical current.</i>	–
Evaluate energy changes in chemical reactions.	Bonds and Activation Energy Endothermic Reactions Exothermic Reactions
<i>Use knowledge of conservation of energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion).</i>	–
<i>Explain resistance, current and electro-motive force (Ohm's Law).</i>	*
C. Distinguish among the principles of force and motion.	

Identify the relationship of electricity and magnetism as two aspects of a single electromagnetic force.	*
Identify elements of simple machines in compound machines.	—
Explain fluid power systems through the design and construction of appropriate models.	—
Describe sound effects (e.g., Doppler effect, amplitude, frequency, reflection, refraction, absorption, sonar, seismic).	*
Describe light effects (e.g., Doppler effect, dispersion, absorption, emission spectra, polarization, interference).	*
Describe and measure the motion of sound, light and other objects.	*
Know Newton's laws of motion (including inertia, action and reaction) and gravity and apply them to solve problems related to forces and mass.	*
Determine the efficiency of mechanical systems by applying mathematical formulas.	—
D. Explain essential ideas about the composition and structure of the universe.	
Compare the basic structures of the universe (e.g., galaxy types, nova, black holes, neutron stars).	*
Describe the structure and life cycle of star, using the Hertzsprung- Russell diagram.	—
Describe the nuclear processes involved in energy production in a star.	*
Explain the "red-shift" and Hubble's use of it to determine stellar distance and movement.	*
Compare absolute versus apparent star magnitude and their relation to stellar distance.	—
Explain the impact of the Copernican and Newtonian thinking on man's view of the universe.	—
Identify and analyze the findings of several space instruments in regard to the extent and composition of the solar system and universe.	—
Grade 12	
A. Apply concepts about the structure and properties of matter.	
Apply rules of systematic nomenclature and formula writing to chemical substances.	Naming Compounds Reacting Masses Types of Formulae
Classify and describe, in equation form, types of chemical and nuclear reactions.	Reacting Masses
Explain how radioactive isotopes that are subject to decay can be used to estimate the age of materials.	Radioactivity Radioactive Dating Types of Radiation
Explain how the forces that bind solids, liquids and gases affect their properties.	Intermolecular Forces Particles in Action
Characterize and identify important classes of compounds (e.g., acids, bases, salts).	Compounds Naming Compounds
Apply the conservation of energy concept to fields as diverse as mechanics, nuclear particles and studies of the origin of the universe.	*

Apply the predictability of nuclear decay to estimate the age of materials that contain radioactive isotopes.	Radioactive Dating
<i>Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.</i>	–
B. Apply and analyze energy sources and conversions and their relationship to heat and temperature.	
Determine the heat involved in illustrative chemical reactions.	Calorimetry Endothermic Reactions Exothermic Reactions
<i>Evaluate mathematical formulas that calculate the efficiency of specific chemical and mechanical systems.</i>	–
Use knowledge of oxidation and reduction to balance complex reactions.	Redox Reactions
Apply appropriate thermodynamic concepts (e.g., conservation, entropy) to solve problems relating to energy and heat.	Enthalpy Change
C. Apply the principles of motion and force.	
<i>Evaluate wave properties of frequency, wavelength and speed as applied to sound and light through different media.</i>	*
<i>Propose and produce modifications to specific mechanical power systems that will improve their efficiency.</i>	*
<i>Analyze the principles of translational motion, velocity and acceleration as they relate to free fall and projectile motion.</i>	*
<i>Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque.</i>	*
<i>Interpret a model that illustrates circular motion and acceleration.</i>	*
<i>Describe inertia, motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.</i>	*
D. Analyze the essential ideas about the composition and structure of the universe.	
<i>Analyze the Big Bang Theory's use of gravitation and nuclear reaction to explain a possible origin of the universe.</i>	*
<i>Compare the use of visual, radio and x-ray telescopes to collect data regarding the structure and evolution of the universe.</i>	*
<i>Correlate the use of the special theory of relativity and the life of a star.</i>	*

* See Boardworks High School Physics for relevant presentations.