

# High School: Chemistry

Adopted 2018

## High School - Chemistry

### 1. Mathematical and Computational Analysis CHE.1

1A. Students will use mathematical and computational analysis to evaluate problems. CHE.1A

1. Use dimensional analysis (factor/label) and significant figures to convert units and solve problems. CHE.1A.1
2. Design and conduct experiments using appropriate measurements, significant figures, graphical analysis to analyze data. CHE.1A.2
3. Enrichment: Research information from multiple appropriate sources and assess the credibility, accuracy, possible bias, and conclusions of each publication. CHE.1A.3

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### 2. Atomic Theory CHE.2

2A. Students will demonstrate an understanding of the atomic structure and the historical developments leading to modern atomic theory. CHE.2A

1. Investigate the historical progression leading to the modern atomic theory, including, but not limited to, work done by Dalton, Rutherford's gold foil experiment, Thomson's cathode ray experiment, Millikan's oil drop experiment, and Bohr's interpretation of bright line spectra. CHE.2A.1
2. Construct models (e.g., ball and stick, online simulations, mathematical computations) of atomic nuclei to explain the abundance weighted average (relative mass) of elements and isotopes on the published mass of elements. CHE.2A.2
3. Investigate absorption and emission spectra to interpret explanations of electrons at discrete energy levels using tools such as online simulations, spectrometers, prisms, flame tests, and discharge tubes. Explore both laboratory experiments and real-world examples. CHE.2A.3
4. Research appropriate sources to evaluate the way absorption and emission spectra are used to study astronomy and the formation of the universe. CHE.2A.4

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### 3. Periodic Table CHE.3

- 3A. Students will demonstrate an understanding of the periodic table as a systematic representation to predict properties of elements. CHE.3A
1. Explore and communicate the organization of the periodic table, including history, groups, families, family names, metals, nonmetals, metalloids, and transition metals. CHE.3A.1
  2. Analyze properties of atoms and ions (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity and electron affinity, ionization energy, and atomic/ionic radii) using periodic trends of elements based on the periodic table. CHE.3A.2
  3. Analyze the periodic table to identify quantum numbers (e.g., valence shell electrons, energy level, orbitals, sublevels, and oxidation numbers). CHE.3A.3

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### 4. Bonding CHE.4

- 4A. Students will demonstrate an understanding of the types of bonds and resulting atomic structures for the classification of chemical compounds. CHE.4A
1. Develop and use models (e.g., Lewis dot, 3-D ball-stick, 3-D printing, or simulation programs such as PhET) to predict the type of bonding between atoms and the shape of simple compounds. CHE.4A.1
  2. Use models such as Lewis structures and ball and stick models to depict the valence electrons and their role in the formation of ionic and covalent bonds. CHE.4A.2
  3. Predict the ionic or covalent nature of different atoms based on electronegativity trends and/or position on the periodic table. CHE.4A.3
  4. Use models and oxidation numbers to predict the type of bond, shape of the compound, and the polarity of the compound. CHE.4A.4
  5. Use models of simple hydrocarbons to exemplify structural isomerism. CHE.4A.5
  6. Use mathematical and computational analysis to determine the empirical formula and the percent composition of compounds. CHE.4A.6
  7. Use scientific investigation to determine the percentage of composition for a substance (e.g., sugar in gum, water and/or unpopped kernels in popcorn, percent water in a hydrate). Compare results to justify conclusions based on experimental evidence. CHE.4A.7
  8. Plan and conduct controlled scientific investigations to produce mathematical evidence of the empirical composition of a compound. CHE.4A.8

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## 5. Naming Compounds CHE.5

- 5A. Students will investigate and understand the accepted nomenclature used to identify the name and chemical formulas of compounds. CHE.5A
1. Use the periodic table and a list of common polyatomic ions as a model to derive chemical compound formulas from compound names and compound names from chemical formulas. CHE.5A.1
  2. Generate formulas of ionic and covalent compounds from compound names. Discuss compounds in everyday life and compile lists and uses of these chemicals. CHE.5A.2
  3. Generate names of ionic and covalent compounds from their formulas. Name binary compounds, binary acids, stock compounds, ternary compounds, and ternary acids. CHE.5A.3

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## 6. Chemical Reactions CHE.6

- 6A. Students will demonstrate an understanding of the types, causes, and effects of chemical reactions. CHE.6A
1. Develop and use models to predict the products of chemical reactions (e.g., synthesis reactions; single replacement; double displacement; and decomposition, including exceptions such as decomposition of hydroxides, chlorates, carbonates, and acids). Discuss and/or compile lists of reactions used in everyday life. CHE.6A.1
  2. Plan, conduct, and communicate the results of investigations to demonstrate different types of simple chemical reactions. CHE.6A.2
  3. Use mathematics and computational analysis to represent the ratio of reactants and products in terms of masses, molecules, and moles (stoichiometry). CHE.6A.3
  4. Use mathematics and computational analysis to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Give real-world examples (e.g., burning wood). CHE.6A.4
  5. Plan and conduct a controlled scientific investigation to produce mathematical evidence that mass is conserved. Use percent error to analyze the accuracy of results. CHE.6A.5
  6. Use mathematics and computational analysis to support the concept of percent yield and limiting reagent. CHE.6A.6
  7. Plan and conduct a controlled scientific investigation to produce mathematical evidence to predict and confirm the limiting reagent and percent yield in the reaction. Analyze quantitative data, draw conclusions, and communicate findings. Compare and analyze class data for validity. CHE.6A.7

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## 7. Gas Laws CHE. 7

- 7A. Students will demonstrate an understanding of the structure and behavior of gases. CHE. 7A
1. Analyze the behavior of ideal and real gases in terms of pressure, volume, temperature, and number of particles. CHE. 7A. 1
  2. Enrichment: Use an engineering design process to develop models (e.g., online simulations or student interactive activities) to explain and predict the behavior of each state of matter using the movement of particles and intermolecular forces to explain the behavior of matter. CHE. 7A. 2
  3. Analyze and interpret heating curve graphs to explain the energy relationship between states of matter (e.g., thermochemistry-water heating from -20oC to 120oC). CHE. 7A. 3
  4. Use mathematical computations to describe the relationships comparing pressure, temperature, volume, and number of particles, including Boyle's law, Charles's law, Dalton's law, combined gas laws, and ideal gas laws. CHE. 7A. 4
  5. Enrichment: Use an engineering design process and online simulations or lab investigations to design and model the results of controlled scientific investigations to produce mathematical evidence that confirms the gas-laws relationships. CHE. 7A. 5
  6. Use the ideal gas law to support the prediction of volume, mass, and number of particles produced in chemical reactions (i.e., gas stoichiometry). CHE. 7A. 6
  7. Plan and conduct controlled scientific investigations to produce mathematical evidence that confirms that reactions involving gases conform to the law of conservation of mass. CHE. 7A. 7
  8. Enrichment: Using gas stoichiometry, calculate the volume of carbon dioxide needed to inflate a balloon to occupy a specific volume. Use an engineering design process to design, construct, evaluate, and improve a simulated air bag. CHE. 7A. 8

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## 8. Solutions CHE.8

- 8A. Students will demonstrate an understanding of the nature of properties of various types of chemical solutions. CHE.8A
1. Use mathematical and computational analysis to quantitatively express the concentration of solutions using the concepts such as molarity, percent by mass, and dilution. CHE.8A.1
  2. Develop and use models (e.g., online simulations, games, or video representations) to explain the dissolving process in solvents on the molecular level. CHE.8A.2
  3. Analyze and interpret data to predict the effect of temperature and pressure on solids and gases dissolved in water. CHE.8A.3
  4. Design, conduct, and communicate the results of experiments to test the conductivity of common ionic and covalent compounds in solution. CHE.8A.4
  5. Use mathematical and computational analysis to analyze molarity, molality, dilution, and percentage dilution problems. CHE.8A.5
  6. Design, conduct, and communicate the results of experiments to produce a specified volume of a solution of a specific molarity, and dilute a solution of a known molarity. CHE.8A.6
  7. Use mathematical and computational analysis to predict the results of reactions using the concentration of solutions (i.e., solution stoichiometry). CHE.8A.7
  8. Enrichment: Investigate parts per million and/or parts per billion as it applies to environmental concerns in your geographic region, and reference laws that govern these factors. CHE.8A.8