

# Minneapolis Public Schools Chemistry – Grades 10-12 STANDARDS AND BENCHMARKS ADDRESSED

## KEY TO THE FOLLOWING STANDARDS FORMAT:

- *Italics indicates language added to the state standards by Minneapolis teachers.*
- **Bold words indicate “Power Benchmarks” that should be addressed in detail.**
- The other benchmarks are to be addressed when possible but as time permits.

## II. PHYSICAL SCIENCE

### A. STRUCTURE OF MATTER

The student will understand the nature of matter including its forms, properties and interactions.

#### State Benchmarks:

1. The student will identify protons, neutrons and electrons as the major components of the atom, their mass relative to one another, their arrangement and their charge.
2. **The student will be able to explain the relationship of an element’s position on the periodic table to its atomic number and atomic mass.**
3. The student will compare and contrast the properties of an element and its isotopes, and describe how isotopes can be used in research, medicine and industry.
4. The student will use the periodic table to identify regions, families, groups and periods.
5. The student will explain, *using valence electrons*, how neutral atoms become ions.
6. **The student will be able to explain how atoms form compounds through bonding; and *how bonding influences the character, shape and polarity of a compound.***
7. **The student will compare and contrast the states of matter in terms of interactions between particles.**
8. The student will differentiate between an atom and a molecule.
9. The student will differentiate between an element and compound.
10. *The student will identify elements based on electron configurations.*
11. ***The student will use the combined gas law to predict changes in an ideal gas sample.***
12. ***The student will use chemical bonds and intermolecular forces to explain physical properties, including conductivity, malleability, solubility, hardness, melting point, and boiling point.***
13. ***The student will understand that the outermost electrons in an atom are called the valence electrons, and in general, the number of valence electrons affects the chemical properties of an element, and its behavior during bonding.***
14. *The student will distinguish between classes of compounds based upon bonding type and degree of*

polarity.

15. *The student will know that a solution is a homogeneous mixture of a solute dissolved in a solvent. **The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical nature of the solute and solvent.***
16. *The student will understand that the concentration of a solution may be expressed as molarity (M), percent by volume, percent by mass, or parts per million (ppm).*
17. *The student will understand that the addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point to decrease. The greater the concentration of particles, the greater the effect.*

## **B. CHEMICAL REACTIONS**

The student will describe chemical reactions and the factors that influence them.

### **State Benchmarks:**

1. **The student will describe chemical reactions using words and symbolic equations, using IUPAC names.**
2. The student will explain the influence of temperature, surface area, agitation and catalysts on the rate of a reaction.
3. **The student will distinguish between a chemical reaction and a nuclear reaction.**
4. **The student will explain how the rearrangement of atoms and molecules in a chemical reaction illustrates conservation of mass.**
5. **The student will describe how combining acids and bases produce a neutral solution.**
6. *The student will understand that the types of chemical reaction include synthesis, decomposition, single replacement, and double replacement, combustion, respiration and photosynthesis. (Predict the products only)*
7. *The student will use the mole concept to make stoichiometric predictions and limiting reactions.*
8. *The student will know that the collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.*
9. *The student will understand that some chemical and physical changes can reach equilibrium.*
10. *The student will know that at equilibrium the rate of forward reaction equals the rate of the reverse reaction.*
11. *The student will use LeChatelier's principle to predict the effect of stress (change in pressure, volume, concentration and temperature) on a system at equilibrium.*
12. *The student will use a potential energy diagram to represent the energy released or absorbed by a chemical reaction.*
13. *The student will calculate the energy released or absorbed during a chemical reaction (heat of reaction).*

14. *The student will know that a catalyst provides an alternative reaction pathway, which has a lower activation energy than an uncatalyzed reaction.*
15. *The student will understand that entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.*
16. *The student will understand that systems in nature tend to undergo change toward lower energy and higher entropy.*
- 17. *The student will determine that an oxidation-reduction reaction involves the transfer of electrons (e<sup>-</sup>).***
18. *The student will know that oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.*
19. *The student will determine that the shape of the molecule and the distribution of charge indicate the molecular polarity. Symmetrical (nonpolar) molecules include CO<sub>2</sub>, CH<sub>4</sub>, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH<sub>3</sub>, and H<sub>2</sub>O.*

### **C. ENERGY TRANSFORMATIONS**

The student will understand energy forms, transformations and transfers.

#### **State Benchmarks:**

- 1. The student will be able to describe physical and chemical changes in terms of the law of conservation of energy.**
- 2. The student will compare and contrast the amount of energy released through chemical reactions and nuclear fission and fusion.**
- 3. The student will describe the risks and benefits of fossil fuels, renewable sources and nuclear power as sources of usable energy.**
- 4. The student will describe applications of the different wavelengths of the electromagnetic spectrum.**
- 5. *The student will determine that each radioactive isotope has a specific mode and rate of decay (half-life).***

## **III. EARTH AND SPACE SCIENCE**

### **A. EARTH STRUCTURE AND PROCESSES**

The student will understand that the interactions of the atmosphere, biosphere, lithosphere, hydrosphere and space have resulted in ongoing change of the Earth system over geologic time.

#### **State Benchmark:**

- 1. The student will apply the laws of thermodynamics to explain the cycling of materials and transfer of energy in the Earth system.**

### **C. THE UNIVERSE**

The student will use astronomical data to reveal the structure, scale, and changes in the stars, galaxies and universe over time.

#### **State Benchmark:**

1. The student will explain how nuclear fusion produces energy and other elements.

## **I. HISTORY AND NATURE OF SCIENCE**

### **A. SCIENTIFIC WORLD VIEW**

The student will understand the ways of scientific thinking and that scientific knowledge changes and accumulates over time.

#### **State Benchmarks:**

1. The student will be able to distinguish among hypothesis, theory and law as scientific terms and how they are used to answer a specific question.
2. The student will be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including but not limited to cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease and big bang theory.
3. The student will recognize that in order to be valid, scientific knowledge must meet certain criteria including that it: be consistent with experimental, observational and inferential evidence about nature; follow rules of logic and reporting both methods and procedures; and, be falsifiable and open to criticism.
4. The student will explain how traditions of ethics, peer review, conflict and general consensus influences the conduct of science.
5. The student will recognize that some scientific ideas are incomplete, and opportunity exists in these areas for new advances.

### **B. SCIENTIFIC INQUIRY**

The student will design and conduct a scientific investigation.

#### **State Benchmarks:**

1. The student will design and complete a scientific experiment using scientific methods by determining a testable question, making a hypothesis, designing a scientific investigation with appropriate controls, analyzing data, making conclusions based on evidence and comparing conclusions to the original hypothesis and prior knowledge.

2. **The student will distinguish between qualitative and quantitative data.**
3. **The student will apply mathematics and models to analyze data and support conclusions.**
4. **The student will identify possible sources of error and their effects on results.**
5. The student will know that professional scientists and engineers have ethical codes.
6. The student will give examples of how different domains of science use different bodies of scientific knowledge and employ different methods to investigate questions.

### **C. SCIENTIFIC ENTERPRISE**

The student will understand the relationship between science and technology and how both are used.

#### **State benchmarks:**

1. The student will compare and contrast the purposes and career opportunities of engineering, technology and science.
2. The student will provide an example of a need or problem identified by science and solved by engineering or technology.
3. The student will provide an example of how technology facilitates new discoveries and the development of scientific knowledge.
4. The student will know that technological changes and scientific advances are often accompanied by social, political, environmental and economic changes.
5. The student will recognize that science and technology are influenced by cultural backgrounds and beliefs and by social needs, attitudes, values and limitations.

### **D. HISTORIC PERSPECTIVES**

The student will recognize the historical and cultural context of scientific endeavors and how they influence each other.

#### **State Benchmarks:**

1. The student will be able to trace the development of a scientific advancement, invention or theory and its impact on society.
2. The student will provide examples of scientific advancements contributed by other civilizations and cultures.
3. The student will compare and contrast the differences between scientific theories and theories from other bodies of knowledge, and the importance of each in a science discussion.