Minnesota Science

Chemistry

Exploring phenomena or engineering problems 9C.1

1 Asking questions and defining problems 9C.1

1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read. 9C.1.1.1

1 Ask questions about the impact of greenhouse gases on the Earth's climate, by analyzing their molecular structure and responses during energy absorption (P: 1, CC: 5, CI: PS1) Emphasis should include natural and human-made sources. Structures should include molecular shape. 9C.1.1.1.1

1 Planning and carrying out investigations 9C.1.2

1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena. 9C.1.2.1

1 Plan and conduct an investigation to gather evidence to compare the structure of substances and infer the strength of electrical forces between particles. (P: 3, CC: 1, CI: PS1) Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles may include ions, atoms, molecules, and networked materials (such as graphite). Examples of collected evidence may include the melting point and boiling point, vapor pressure, and surface tension 9C.1.2.1.1

1 Plan and conduct an investigation of acid-base reactions to test ideas about the concentrations of the hydronium ion in an aqueous solution (pH). (P:3, CC: 3, CI: PS1) Emphasis is on developing an understanding of pH scales and various ways to measure pH. Also included is understanding the relative strength of acidity based on periodic properties of elements, the electronegativity model of electron distribution, empirical dipole moments, and molecular geometry. Examples of investigations may include household chemicals and ocean acidification analogs. 9C.1.2.1.2

Looking at data and empirical evidence to understand phenomena or solve problems 9C.2

2 **Analyzing and interpreting data** 9C.2.1

2 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables. 9C.2.1.1

2 Analyze patterns in air or water quality data to make claims about the causes and severity of a problem and the necessity to remediate or to recommend a treatment process. (P: 4, CC :2, CI: PS3) Emphasis is on the scale of the problem and appropriate use of concentration units. Examples of pollutant data may include ozone, lead, particulates, nitrates, or microorganisms. Examples of remediation may include physical, chemical or biological processes. 9C.2.1.1.1

2 **Using mathematics and computational thinking** 9C.2.2

2 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds. 9C.2.2.1

2 Develop a data simulation, based on observations and experimental data of how the pressure, volume temperature, and mass of a gas are related to each other, to predict the effect on a system of changing one of those variables.** (P: 5, CC: 2, CI: PS1) Emphasis is on applying the kinetic molecular theory of gases to develop gas laws. Example systems may include balloons, tires, or syringes. 9C.2.2.1.1

2 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (P: 5, CC: 5, CI: PS1) Emphasis of the practice is on using mathematical ideas to communicate the proportional relationships between the masses of atoms in the reactants and products. Emphasis of the core idea is on the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. 9C.2.2.1.2

Developing possible explanations of phenomena or designing solutions to engineering problems 9C.3

3 **Developing and using models.** 9C.3.1

- 3 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others. 9C.3.1.1
  - 3 Use the periodic table as a model to predict the relative properties of elements based on the patterns of valence electrons. (P: 2, CC: 1, CI: PS1) Emphasis is on properties that could be predicted from patterns may include reactivity of metals, types of bonds formed (ionic versus covalent), and numbers of bonds formed. 9C.3.1.1.1
  - 3 Develop a model based on evidence to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (P: 2, CC: 5, CI: PS1) Emphasis of the practice is on illustrating the relationships between components of the system. Emphasis of the core idea is on how a chemical reaction is a system that affects the energy change. Examples of models may include molecular level drawings, diagrams, graphs showing the relative energies of reactants and products, and representations showing energy is conserved. Not included is the calculation of the total bond energy change during a chemical reaction from the bond energies of reactants and products. 9C.3.1.1.2
  - 3 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (P: 2, CC: 5, CI: PS1) Emphasis is on simple qualitative models and on the scale of energy released in nuclear processes relative to other kinds of transformations. Not included is quantitative calculations of the energy released. 9C.3.1.1.3

- **Constructing explanations and designing solutions** 9C.3.2
  - Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others. 9C.3.2.1
    - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (P: 6, CC: 1, CI: PS1) Examples of chemical reactions may include synthesis, decomposition, or combustion. 9C.3.2.1.1
    - Apply scientific principles and evidence to provide an explanation about the effects of changing the surface area, agitation, temperature, and concentration of the reacting particles on the rate at which the reaction occurs. (P: 6, CC: 1, CI: PS1) Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules and on simple reactions in which there are only two reactants. Examples of evidence may include temperature, concentration, and rate data; and qualitative relationships between rate and temperature. 9C.3.2.1.2
    - Construct an explanation for the phenomenon of solution creation and identify from patterns how the properties of the resulting solution depend on the interactions between solute and solvent or on concentrations of solutes. (P: 6, CC: 1, CI: PS1) Emphasis is on polarity, solubility, boiling point elevation, freezing point depression, and osmosis. Examples may include salts dissolving to make water hard, road salt, antifreeze, oil spills, reverse osmosis water systems. 9C.3.2.1.3
  - Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.* 9C.3.2.2
    - Evaluate the design and function of products and processes involving organic compounds to meet desired needs in relationship to the molecular structures and in particular, the functional groups involved.* (P: 6, CC: 6,CI: PS1, ETS1) Examples of desired needs are having flexible but durable materials made up of long-chained molecules (polymers and plastics), and having pharmaceuticals designed to interact with specific receptors. 9C.3.2.2.1

Communicating reasons, arguments and ideas to others 9C.4

4 **Obtaining, evaluating and communicating information** 9C.4.2

4 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats. 9C.4.2.1

4 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (P: 8, CC: 6, CI: PS1) Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples may include why electrically conductive materials are often made of metal. 9C.4.2.1.1

4 Review text and online sources to develop a series of questions regarding the chemistry, utility, and safety of nuclear fission. (P: 8, CC: 7,CI: PS1) Emphasis is on evaluating the argument and specific claims in the text including the validity of reasoning as well as the relevance and sufficiency of the evidence. Examples may include fission (nuclear power generation, nuclear weapons) and the use of fission byproducts (nuclear medicine, food irradiation). 9C.4.2.1.2

4 Students will be able to gather information about and communicate the methods that are used a by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems. 9C.4.2.2

4 Communicate and evaluate claims by various stakeholders, including Minnesota American Indian Tribes and communities and other cultures, about the environmental impacts of various chemical processes on natural resources. (P: 8, CC: 2, CI: PS1) Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples of natural resources may include wild rice harvesting, mining of minerals, and access to clean air and water. Examples of chemical processes may include sulfate in water/soil, acid mine drainage, and air and water pollution. 9C.4.2.2.1