

# BEMIDJI AREA SCHOOLS

## SCIENCE INVESTIGATIONS

### Grades 9-12

#### I. HISTORY AND NATURE OF SCIENCE

##### A. Scientific World View

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

The student will:

1. Be able to distinguish among hypothesis, theory and law as scientific terms and how they are used to answer a specific question.

**Activity:** *Black Box investigation and various lab worksheets throughout the course.*

2. 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 atomic theory.

**Activity:** *Notes and daily quiz about the history of the atom*

3. 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.

**Activity:** *Ongoing throughout during conclusion write-up of lab activities (example: Conservation of Matter with Ziploc baggies)*

4. Explain how traditions of ethics, peer review, conflict and general consensus influences the conduct of science

**Activity:** *Galileo's biography discussions  
Scientific method revisited*

5. Recognize that some scientific ideas are incomplete, and opportunity exists in these areas for new advances.

**Activity:** *Nuclear Fusion and Atomic Theory discussions  
Medeleev and the discovery of the periodic table*

##### B. Scientific Inquiry

Standard: The student will design and conduct a scientific investigation.

The student will:

1. 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.

**Activity:** *“Plop Fizz” (rate of reaction) lab*  
*“Device” making lab: e.g.: rollercoaster or catapult*  
*“Table Salt vs. Rock salt” for roads lab*

2. Distinguish between qualitative and quantitative data.

**Activity:** *Ongoing throughout the course, collecting data by measuring and by observing.*

3. Apply mathematics and models to analyze data and support conclusions.

**Activity:** *Math: Calculations, using data collected in lab to find the following: Calories, joules, speed, density, force, acceleration etc.*  
**Models:** *Atomic, Kinetic theories and Structural formula models*

4. Identify possible sources of error and their effects on results.

**Activity:** *Ongoing, an evaluation of lab experiences via analysis*

5. Know that professional scientists and engineers have ethical codes.

**Activity:** *Patient laws discussion*

### C. Scientific enterprise

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

The student will:

1. Compare and contrast the purposes and career opportunities of engineering, technology and science.

**Activity:** *Career project and videos*

2. Provide an example of a need or problem identified by science and solved by engineering or technology.

**Activity:** *Career project and videos*

3. Provide an example of how technology facilitates new discoveries and the development of scientific knowledge.

**Activity:** *Career project and videos*

4. Know that technological changes and scientific advances are often accompanied by social, political, environmental and economic changes.

**Activity:** *Career project and videos*

5. Recognize that science and technology are influenced by cultural backgrounds and beliefs and by social needs, attitudes, values and limitations.

**Activity:** *Career project and videos*

#### **D. Historic perspectives**

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

The student will:

1. Be able to trace the development of a scientific advancement, invention or theory and its impact on society.  
**Activity:** *History of Science Project*
2. Provide examples of scientific advancements contributed by other civilizations and cultures.  
**Activity:** *History of Science Project*
3. Compare and contrast the differences between scientific theories and theories from other bodies of knowledge, and the importance of each in a science discussion.  
**Activity:** *History of Science Project*

## **II. PHYSICAL SCIENCE**

#### **A. Structure of Matter**

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

The student will:

1. Identify protons, neutrons and electrons as the major components of the atom, their mass relative to one another, their arrangement and their charge.  
**Activity:** *Elemental Dice Game*
2. Be able to explain the relationship of an element's position on the periodic table to its atomic number and atomic mass.  
**Activity:** *Metal Reactivity Demonstration*
3. Compare and contrast the properties of an element and its isotopes, and describe how isotopes can be used in research, medicine and industry.  
**Activity:** *Half-life probability lab*
4. Use the periodic table to identify regions, families, groups and periods.  
**Activity:** *Notes and Quiz: Tour of Periodic table and Notes*
5. Explain how neutral atoms become ions.  
**Activity:** *Notes and Quiz: How an atom gets charged, diagram atoms*
6. Be able to explain how atoms form compounds through bonding.  
**Activity:** *Notes: Stable octet, electron dot models, atom diagrams*
7. Compare and contrast the states of matter in terms of interactions between particles.  
**Activity:** *Phase change of water lab activity and analysis via graphing*

- Differentiate between an atom and a molecule.  
**Activity:** *Formula writing worksheets and notes, lab: Identify Mix, Cpd. Element*
- Differentiate between an element and a compound.  
**Activity Lab and Notes:** *Identify Mixture Compound Elements*

## **B. Chemical Reactions**

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

The student will:

- Describe chemical reactions using words and symbolic equations.  
**Activity:** *Lab activities where there is a chemical reaction e.g.: Copper Solubility and Pick up the Pace*
- Explain the influence of temperature, surface area, agitation and catalysts on the rate of a reaction.  
**Activity:** *Plop Fizz Lab, Blues in a Beaker lab, Candy Hearts lab or hydrogen peroxide with  $MnO_2$*
- Explain how the rearrangement of atoms and molecules in a chemical reaction illustrates conservation of mass.  
**Activity:** *Conservation of Matter Lab, notes and worksheets on types of Reactions*
- Describe how combining acids and bases produce a neutral solution.  
**Activity:** *Acid/Base packets, Tums vs. Rolaids lab, pH of Samples*

## **C. Energy Transformations**

Standard: The student will understand energy forms, transformations and transfers.

The student will:

- Know that potential energy is stored energy and is associated with gravitational or electrical force, mechanical position or chemical composition.  
**Activity:** *Bouncy Ball Lab, P.E. vs K.E. lab*
- Differentiate between kinetic and potential energy and identify situations where kinetic energy is converted into potential energy and vice versa.  
**Activity:** *Bouncy Ball Lab*
- Differentiate between AC and DC current.  
**Activity:** *Notes and Battery demonstration*
- Describe the production, storage and transmission of electricity.  
**Activity:** *Circuit Lab*

5. Be able to describe physical and chemical changes in terms of the law of conservation of energy.  
**Activity:** *Bouncy Ball Lab*
6. Describe the risks and benefits of fossil fuels, renewable sources and nuclear power as sources of usable energy.  
**Activity:** *“Cars of the Future” video by Alan Alda and Energy Project*
7. Describe applications of the different wavelengths of the electromagnetic spectrum.  
**Activity:** *Flame test and notes*
8. Describe energy, work and power both conceptually and quantitatively.  
**Activity:** *Power up Stairs Lab, Pulley Labs, Simple Machine Labs*

#### **D. Motion**

Standard: The student will understand the nature of force and motion.

The student will:

1. Use Newton’s three laws of motion to qualitatively and quantitatively describe the interaction of objects.  
**Activity:** *3 Laws of Newton Demonstration Project, Newton’s 2<sup>ND</sup> Law Lab with carts and mass, 3<sup>rd</sup> Law Lab (collison carts)*
2. Describe the effect of friction and gravity on the motion of an object.  
**Activity:** *Friction Lab, Gravity Demo*

#### **E. Forces of Nature**

Standard: The student will understand the forces of nature and their application.

The student will:

1. Identify the dominant force or forces in a variety of interactions.  
**Activity:** *Notes and identification of balanced and unbalanced forces*