

1.1 **Department of Education**

1.2 **Adopted Permanent Rules Relating to Academic Standards in Science**

1.3 **ACADEMIC STANDARDS FOR IN SCIENCE**

1.4 **3501.0800 KINDERGARTEN STANDARDS.**

1.5 Subpart 1. **The nature of science and engineering.**

1.6 A. The practice of science. The student will understand that scientific inquiry
1.7 is a set of interrelated processes used to pose questions about the natural world and
1.8 investigate phenomena.

1.9 B. The practice of engineering. The student will understand that some objects
1.10 occur in nature. The student will understand that others have been designed and processed
1.11 by people.

1.12 Subp. 2. **Physical science; matter.** The student will understand that objects can be
1.13 described in terms of the materials they are made of and their physical properties.

1.14 Subp. 3. **Earth and space science; interdependence within the earth system.**
1.15 The student will understand that weather can be described in measurable quantities and
1.16 changes from day to day and with the seasons.

1.17 Subp. 4. **Life science.**

1.18 A. Structure and function in living systems. The student will understand that
1.19 living things are diverse with many different observable characteristics.

1.20 B. Interdependence among living systems. The student will understand that
1.21 natural systems have many components that interact to maintain the living system.

1.22 **3501.0805 GRADE 1 STANDARDS.**

1.23 Subpart 1. **The nature of science and engineering.**

2.1 A. The practice of science. The student will understand that scientists work
2.2 as individuals and in groups to investigate the natural world, emphasizing evidence and
2.3 communicating with others.

2.4 B. Interactions among science, technology, engineering, mathematics, and
2.5 society. The student will understand that designed and natural systems exist in the world.
2.6 The student will understand that these systems are made up of components that act within
2.7 a system and interact with other systems.

2.8 C. Interactions among science, technology, engineering, mathematics, and
2.9 society. The student will understand that men and women throughout the history of
2.10 all cultures, including Minnesota American Indian tribes and communities, have been
2.11 involved in engineering design and scientific inquiry.

2.12 Subp. 2. **Earth and space science; earth structure and processes.** The student
2.13 will understand that earth materials include solid rocks, sand, soil, and water. The student
2.14 will understand that these materials have different observable physical properties that
2.15 make them useful.

2.16 Subp. 3. **Life science.**

2.17 A. Structure and function in living systems. The student will understand that
2.18 living things are diverse with many different observable characteristics.

2.19 B. Interdependence among living systems. The student will understand that
2.20 natural systems have many components that interact to maintain the living system.

2.21 C. Evolution in living systems. The student will understand that plants and
2.22 animals undergo a series of orderly changes during their life cycles.

2.23 **3501.0810 GRADE 2 STANDARDS.**

2.24 Subpart 1. **The nature of science and engineering.**

3.1 A. The practice of science. The student will understand that scientific inquiry
3.2 is a set of interrelated processes incorporating multiple approaches that are used to pose
3.3 questions about the natural world and investigate phenomena.

3.4 B. The practice of engineering. The student will understand that engineering
3.5 design is the process of identifying a problem and devising a product or process to solve
3.6 the problem.

3.7 Subp. 2. **Physical science.**

3.8 A. Matter. The student will understand that objects can be described in terms of
3.9 the materials they are made of and their physical properties.

3.10 B. Matter. The student will understand that the physical properties of materials
3.11 can be changed, but not all materials respond the same way to what is done to them.

3.12 C. Motion. The student will understand that the motion of an object can be
3.13 described by a change in its position over time.

3.14 D. Motion. The student will understand that the motion of an object can be
3.15 changed by push or pull forces.

3.16 Subp. 3. **Earth and space science; interdependence within the earth system.**

3.17 The student will understand that weather can be described in measurable quantities and
3.18 changes from day to day and with the seasons.

3.19 Subp. 4. **Life science.**

3.20 A. Structure and function in living systems. The student will understand that
3.21 living things are diverse with many different observable characteristics.

3.22 B. Interdependence among living systems. The student will understand that
3.23 natural systems have many components that interact to maintain the living system.

4.1 C. Evolution in living systems. The student will understand that plants and
4.2 animals undergo a series of orderly changes during their life cycles.

4.3 **3501.0815 GRADE 3 STANDARDS.**

4.4 Subpart 1. **The nature of science and engineering.**

4.5 A. The practice of science. The student will understand that scientists work as
4.6 individuals and in groups, emphasizing evidence, open communication, and skepticism.

4.7 B. The practice of science. The student will understand that scientific inquiry
4.8 is a set of interrelated processes incorporating multiple approaches that are used to pose
4.9 questions about the natural world and investigate phenomena.

4.10 C. Interactions among science, technology, engineering, mathematics, and
4.11 society. The student will understand that men and women throughout the history of
4.12 all cultures, including Minnesota American Indian tribes and communities, have been
4.13 involved in engineering design and scientific inquiry.

4.14 D. Interactions among science, technology, engineering, mathematics, and
4.15 society. The student will understand that tools and mathematics help scientists and
4.16 engineers see more, measure more accurately, and do things that they could not otherwise
4.17 accomplish.

4.18 Subp. 2. **Physical science; energy.** The student will understand that energy appears
4.19 in different forms, including sound and light.

4.20 Subp. 3. **Earth and space science.**

4.21 A. The universe. The student will understand that the sun and moon have
4.22 locations and movements that can be observed and described.

4.23 B. The universe. The student will understand that objects in the solar system as
4.24 seen from Earth have various sizes and distinctive patterns of motion.

5.1 **Subp. 4. Life science.**

5.2 A. Structure and function in living systems. The student will understand that
5.3 living things are diverse with many different characteristics that enable them to grow,
5.4 reproduce, and survive.

5.5 B. Evolution in living systems. The student will understand that offspring are
5.6 generally similar to their parents, but may have variations that can be advantageous or
5.7 disadvantageous in a particular environment.

5.8 **3501.0820 GRADE 4 STANDARDS.**

5.9 **Subpart 1. The nature of science and engineering.**

5.10 A. The practice of engineering. The student will understand that engineers
5.11 design, create, and develop structures, processes, and systems that are intended to improve
5.12 society and may make humans more productive.

5.13 B. The practice of engineering. The student will understand that engineering
5.14 design is the process of identifying problems, developing multiple solutions, selecting the
5.15 best possible solution, and building the product.

5.16 C. Interactions among science, technology, engineering, mathematics,
5.17 and society. The student will understand that the needs of any society influence the
5.18 technologies that are developed and how they are used.

5.19 **Subp. 2. Physical science.**

5.20 A. Matter. The student will understand that objects have observable properties
5.21 that can be measured.

5.22 B. Matter. The student will understand that solids, liquids, and gases are states
5.23 of matter that have unique properties.

6.1 C. Energy. The student will understand that energy appears in different forms,
6.2 including heat and electromagnetism.

6.3 D. Energy. The student will understand that energy can be transformed within a
6.4 system or transferred to other systems or the environment.

6.5 Subp. 3. **Earth and space science.**

6.6 A. Earth structure and processes. The student will understand that rocks are
6.7 Earth materials that may vary in composition.

6.8 B. Interdependence within the Earth system. The student will understand that
6.9 water circulates through the Earth's crust, oceans, and atmosphere in what is known as
6.10 the water cycle.

6.11 C. Human interactions with Earth systems. The student will understand that in
6.12 order to improve their existence, humans interact with and influence Earth systems.

6.13 Subp. 4. **Life science; human interactions with living systems.** The student will
6.14 understand that microorganisms can get inside one's body and they may keep it from
6.15 working properly.

6.16 **3501.0825 GRADE 5 STANDARDS.**

6.17 Subpart 1. **The nature of science and engineering.**

6.18 A. The practice of science. The student will understand that science is a way of
6.19 knowing about the natural world, is done by individuals and in groups, and is characterized
6.20 by empirical criteria, logical argument, and skeptical review.

6.21 B. The practice of science. The student will understand that scientific
6.22 inquiry requires identification of assumptions, use of critical and logical thinking, and
6.23 consideration of alternative explanations.

7.1 C. Interactions among science, technology, engineering, mathematics, and
7.2 society. The student will understand that men and women throughout the history of
7.3 all cultures, including Minnesota American Indian tribes and communities, have been
7.4 involved in engineering design and scientific inquiry.

7.5 D. Interactions among science, technology, engineering, mathematics, and
7.6 society. The student will understand that tools and mathematics help scientists and
7.7 engineers see more, measure more accurately, and do things that they could not otherwise
7.8 accomplish.

7.9 Subp. 2. **Physical science; motion.** The student will understand that an object's
7.10 motion is affected by forces and can be described by the object's speed and the direction it
7.11 is moving.

7.12 Subp. 3. **Earth and space science.**

7.13 A. Earth structure and processes. The student will understand that the surface
7.14 of the Earth changes. The student will understand that some changes are due to slow
7.15 processes and some changes are due to rapid processes.

7.16 B. Human ~~interaction~~ interactions with Earth systems. The student will
7.17 understand that in order to maintain and improve their existence, humans interact with and
7.18 influence Earth systems.

7.19 Subp. 4. **Life science.**

7.20 A. Structure and function in living systems. The student will understand that
7.21 living things are diverse with many different characteristics that enable them to grow,
7.22 reproduce, and survive.

7.23 B. Interdependence among living systems. The student will understand that
7.24 natural systems have many ~~parts~~ components that interact to maintain the living system.

8.1 C. Human interactions with living systems. The student will understand
8.2 that humans change environments in ways that can be either beneficial or harmful to
8.3 themselves and other organisms.

8.4 **3501.0830 GRADE 6 STANDARDS.**

8.5 Subpart 1. **The nature of science and engineering.**

8.6 A. The practice of engineering. The student will understand that engineers
8.7 create, develop, and manufacture machines, structures, processes, and systems that impact
8.8 society and may make humans more productive.

8.9 B. The practice of engineering. The student will understand that engineering
8.10 design is the process of devising products, processes, and systems that address a need,
8.11 capitalize on an opportunity, or solve a specific problem.

8.12 C. Interactions among science, technology, engineering, mathematics, and
8.13 society. The student will understand that designed and natural systems exist in the world.
8.14 The student will understand that these systems consist of components that act within
8.15 the system and interact with other systems.

8.16 D. Interactions among science, technology, engineering, mathematics, and
8.17 society. The student will understand that current and emerging technologies have enabled
8.18 humans to develop and use models to understand and communicate how natural and
8.19 designed systems work and interact.

8.20 Subp. 2. **Physical science.**

8.21 A. Matter. The student will understand that pure substances can be identified by
8.22 properties which are independent of the sample of the substance and the properties can be
8.23 explained by a model of matter that is composed of small particles.

9.1 B. Matter. The student will understand that substances can undergo physical
9.2 changes which do not change the composition or the total mass of the substance in a
9.3 closed system.

9.4 C. Motion. The student will understand that the motion of an object can be
9.5 described in terms of speed, direction, and change of position.

9.6 D. Motion. The student will understand that forces have magnitude and
9.7 direction and ~~govern~~ affect the motion of objects.

9.8 E. Energy. The student will understand that waves involve the transfer of
9.9 energy without the transfer of matter.

9.10 F. Energy. The student will understand that energy can be transformed within a
9.11 system or transferred to other systems or the environment.

9.12 **3501.0835 GRADE 7 STANDARDS.**

9.13 Subpart 1. **The nature of science and engineering.**

9.14 A. The practice of science. The student will understand that science is a way
9.15 of knowing about the natural world and is characterized by empirical criteria, logical
9.16 argument, and skeptical review.

9.17 B. The practice of science. The student will understand that scientific inquiry
9.18 uses multiple interrelated processes to investigate questions and propose explanations
9.19 about the natural world.

9.20 C. Interactions among science, technology, engineering, mathematics, and
9.21 society. The student will understand that current and emerging technologies have enabled
9.22 humans to develop and use models to understand and communicate how natural and
9.23 designed systems work and interact.

10.1 Subp. 2. **Physical science; matter.** The student will understand that the idea that
10.2 matter is made up of atoms and molecules provides the basis for understanding the
10.3 properties of matter.

10.4 Subp. 3. **Life science.**

10.5 A. Structure and function in living systems. The student will understand that
10.6 tissues, organs, and organ systems are composed of cells and function to serve the needs
10.7 of all cells for food, air, and waste removal.

10.8 B. Structure and function in living systems. The student will understand that
10.9 all organisms are composed of one or more cells which carry on the many functions
10.10 needed to sustain life.

10.11 C. Interdependence among living systems. The student will understand that
10.12 natural systems include a variety of organisms that interact with one another in several
10.13 ways.

10.14 D. Interdependence among living systems. The student will understand that the
10.15 flow of energy and the recycling of matter are essential to a stable ecosystem.

10.16 E. Evolution in living systems. The student will understand that reproduction
10.17 is a characteristic of all organisms and is essential for the continuation of a species. The
10.18 student will understand that hereditary information is contained in genes which are
10.19 inherited through asexual or sexual reproduction.

10.20 F. Evolution in living systems. The student will understand that individual
10.21 organisms with certain traits in particular environments are more likely than others to
10.22 survive and have offspring.

10.23 G. Human interactions with living systems. The student will understand that
10.24 human activity can change living organisms and ecosystems.

11.1 H. Human interactions with living systems. The student will understand that
11.2 human beings are constantly interacting with other organisms that cause disease.

11.3 **3501.0840 GRADE 8 STANDARDS.**

11.4 Subpart 1. **The nature of science and engineering.**

11.5 A. The practice of science. The student will understand that science is a way
11.6 of knowing about the natural world and is characterized by empirical criteria, logical
11.7 argument, and skeptical review.

11.8 B. The practice of science. The student will understand that scientific inquiry
11.9 uses multiple interrelated processes to investigate questions and propose explanations
11.10 about the natural world.

11.11 C. Interactions among science, technology, engineering, mathematics, and
11.12 society. The student will understand that men and women throughout the history of
11.13 all cultures, including Minnesota American Indian tribes and communities, have been
11.14 involved in engineering design and scientific inquiry.

11.15 D. Interactions among science, technology, engineering, mathematics, and
11.16 society. The student will understand that science and engineering operate in the context of
11.17 society and both influence and are influenced by this context.

11.18 E. Interactions among science, technology, engineering, mathematics, and
11.19 society. The student will understand that current and emerging technologies have enabled
11.20 humans to develop and use models to understand and communicate how natural and
11.21 designed systems work and interact.

11.22 Subp. 2. **Physical science.**

11.23 A. Matter. The student will understand that pure substances can be identified by
11.24 properties which are independent of the sample of the substance and the properties can be
11.25 explained by a model of matter that is composed of small particles.

12.1 B. Matter. The student will understand that substances can undergo physical
12.2 changes and chemical changes which may change the properties of the substance but do
12.3 not change the total mass in a closed system.

12.4 C. Energy. The student will understand that waves involve the transfer of
12.5 energy without the transfer of matter.

12.6 Subp. 3. **Earth and space science.**

12.7 A. Earth structure and processes. The student will understand that the movement
12.8 of tectonic plates results from interactions among the lithosphere, mantle, and core.

12.9 B. Earth structure and processes. The student will understand that landforms
12.10 are the result of the combination of constructive and destructive processes.

12.11 C. Earth structure and processes. The student will understand that rocks and
12.12 rock formations indicate evidence of the materials and conditions that produced them.

12.13 D. Interdependence within the Earth system. The student will understand that
12.14 the sun is the principal external energy source for the Earth.

12.15 E. Interdependence within the Earth system. The student will understand that
12.16 patterns of atmospheric movement influence global climate and local weather.

12.17 F. Interdependence within the Earth system. The student will understand that
12.18 water, which covers the majority of the Earth's surface, circulates through the crust,
12.19 oceans, and atmosphere in what is known as the water cycle.

12.20 G. The universe. The student will understand that the Earth is the third planet
12.21 from the sun in a system that includes the moon, the sun, seven other planets and their
12.22 moons, and smaller objects.

12.23 H. Human interactions with Earth systems. The student will understand that
12.24 in order to maintain and improve their existence, humans interact with and influence
12.25 Earth systems.

13.1 **3501.0845 GRADES 9-12 STANDARDS.**

13.2 Subpart 1. **The nature of science and engineering.**

13.3 A. The practice of science. The student will understand that science is a way
13.4 of knowing about the natural world and is characterized by empirical criteria, logical
13.5 argument, and skeptical review.

13.6 B. The practice of science. The student will understand that scientific inquiry
13.7 uses multiple interrelated processes to investigate and explain the natural world.

13.8 C. The practice of engineering. The student will understand that engineering
13.9 is a way of addressing human needs by applying science concepts and mathematical
13.10 techniques to develop new products, tools, processes, and systems.

13.11 D. The practice of engineering. The student will understand that engineering
13.12 design is an analytical and creative process of devising a solution to meet a need or solve
13.13 a specific problem.

13.14 E. Interactions among science, technology, engineering, mathematics, and
13.15 society. The student will understand that natural and designed systems are made up of
13.16 components that act within a system and interact with other systems.

13.17 F. Interactions among science, technology, engineering, mathematics, and
13.18 society. The student will understand that men and women throughout the history of
13.19 all cultures, including Minnesota American Indian tribes and communities, have been
13.20 involved in engineering design and scientific inquiry.

13.21 G. Interactions among science, technology, engineering, mathematics, and
13.22 society. The student will understand that science and engineering operate in the context of
13.23 society and both influence and are influenced by this context.

14.1 H. Interactions among science, technology, engineering, mathematics,
14.2 and society. The student will understand that science, technology, engineering, and
14.3 mathematics rely on each other to enhance knowledge and understanding.

14.4 Subp. 2. **Physical science.**

14.5 A. Matter. The student will understand that the structure of the atom determines
14.6 chemical properties of elements.

14.7 B. Matter. The student will understand that chemical reactions involve the
14.8 rearrangement of atoms as chemical bonds are broken and formed through transferring or
14.9 sharing of electrons and the absorption or release of energy.

14.10 C. Motion. The student will understand that an object's mass and the forces on
14.11 it affect the motion of an object.

14.12 D. Energy. The student will understand that energy can be transformed within a
14.13 system or transferred to other systems or the environment, but is always conserved.

14.14 E. Human ~~interaction~~ interactions with physical systems. The student will
14.15 understand that there are benefits, costs, and risks to different means of generating and
14.16 using energy.

14.17 Subp. 3. **Earth and space science.**

14.18 A. Earth structure and processes. The student will understand that the
14.19 relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers, and
14.20 ocean features provide evidence for the theory of plate tectonics.

14.21 B. Earth structure and processes. The student will understand that by observing
14.22 rock sequences and using fossils to correlate the sequences at various locations, geologic
14.23 events can be inferred and geologic time can be estimated.

15.1 C. Interdependence within the Earth system. The student will understand that
15.2 the Earth system has internal and external sources of energy, which produce heat and drive
15.3 the motion of material in the oceans, atmosphere, and solid earth.

15.4 D. Interdependence within the Earth system. The student will understand that
15.5 global climate is determined by distribution of energy from the sun at the Earth's surface.

15.6 E. Interdependence within the Earth system. The student will understand that
15.7 the cycling of materials through different reservoirs of the Earth's system is powered
15.8 by the Earth's sources of energy.

15.9 F. The universe. The student will understand that the solar system, sun, and
15.10 Earth formed over billions of years.

15.11 G. The universe. The student will understand that the Big Bang theory states
15.12 that the universe expanded from a hot, dense, chaotic mass, after which chemical elements
15.13 formed and clumped together to eventually form stars and galaxies.

15.14 H. Human interactions with ~~the Earth system~~ systems. The student will
15.15 understand that people consider potential benefits, costs, and risks to make decisions
15.16 on how they interact with natural systems.

15.17 Subp. 4. **Life science.**

15.18 A. Structure and function in living systems. The student will understand that
15.19 organisms use the interaction of cellular processes as well as tissues and organ systems
15.20 to maintain homeostasis.

15.21 B. Structure and function in living systems. The student will understand that
15.22 cells and cell structures have specific functions that allow an organism to grow, survive,
15.23 and reproduce.

16.1 C. Interdependence among living systems. The student will understand that
16.2 the interrelationship and interdependence of organisms generate dynamic biological
16.3 communities in ecosystems.

16.4 D. Interdependence among living systems. The student will understand that
16.5 matter cycles and energy flows through different levels of organization of living systems
16.6 and the physical environment, as chemical elements are combined in different ways.

16.7 E. Evolution in living systems. The student will understand that genetic
16.8 information found in the cell provides information for assembling proteins, which dictate
16.9 the expression of traits in an individual.

16.10 F. Evolution in living systems. The student will understand that variation within
16.11 a species is the natural result of new inheritable characteristics occurring from new
16.12 combinations of existing genes or from mutations of genes in reproductive cells.

16.13 G. Evolution in living systems. The student will understand that evolution by
16.14 natural selection is a scientific explanation for the history and diversity of life on Earth.

16.15 H. Human interactions with living systems. The student will understand that
16.16 human activity has consequences on living organisms and ecosystems.

16.17 I. Human interactions with living systems. The student will understand that
16.18 personal and community health can be affected by the environment, body functions,
16.19 and human behavior.

16.20 **3501.0850 GRADES 9-12 CHEMISTRY STANDARDS.**

16.21 **Subpart 1. The nature of science and engineering.**

16.22 A. Interactions among science, technology, engineering, mathematics, and
16.23 society. The student will understand that developments in chemistry affect society and
16.24 societal concerns affect the field of chemistry.

17.1 B. Interactions among science, technology, engineering, mathematics, and
17.2 society. The student will understand that physical and mathematical models are used to
17.3 describe physical systems.

17.4 Subp. 2. **Physical science.**

17.5 A. Matter. The student will understand that the periodic table illustrates how
17.6 patterns in the physical and chemical properties of elements are related to atomic structure.

17.7 B. Matter. The student will understand that chemical and physical properties
17.8 of matter result from the ability of atoms to form bonds.

17.9 C. Matter. The student will understand that chemical reactions describe a
17.10 chemical change in which one or more reactants are transformed into one or more products.

17.11 D. Matter. The student will understand that states of matter can be described
17.12 in terms of motion of molecules and that the properties and behavior of gases can be
17.13 explained using the kinetic molecular theory.

17.14 **3501.0855 GRADES 9-12 PHYSICS STANDARDS.**

17.15 Subpart 1. **The nature of science and engineering.**

17.16 A. Interactions among science, technology, engineering, mathematics, and
17.17 society. The student will understand that developments in physics affect society and
17.18 societal concerns affect the field of physics.

17.19 B. Interactions among science, technology, engineering, mathematics, and
17.20 society. The student will understand that physical and mathematical models are used to
17.21 describe physical systems.

17.22 Subp. 2. **Physical science.**

17.23 A. Motion. The student will understand that forces and inertia determine the
17.24 motion of objects.

18.1 B. Motion. The student will understand that when objects change their motion
18.2 or interact with other objects in the absence of frictional forces, the total amount of
18.3 mechanical energy remains constant.

18.4 C. Energy. The student will understand that sound waves are generated from
18.5 mechanical oscillations of objects and travel through a medium.

18.6 D. Energy. The student will understand that electrons respond to electric fields
18.7 and voltages by moving through electrical circuits and this motion generates magnetic
18.8 fields.

18.9 E. Energy. The student will understand that magnetic and electric fields interact
18.10 to produce electromagnetic waves.

18.11 F. Energy. The student will understand that heat energy is transferred between
18.12 objects or regions that are at different temperatures by the processes of convection,
18.13 conduction, and radiation.