Montana Science

Grades 9, 10, 11, 12

Adopted 2016

Physical Science

1. **Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** PS.9-12.1
2. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** PS.9-12.2
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.** PS.9-12.3
4. **Communicate through scientific and technical information roles of molecular-level structure in the functioning of designed materials.** PS.9-12.4
5. **Construct and revise an explanation for outcomes of simple chemical reactions based on outer electron states of atoms, trends in the periodic table, and patterns of chemical properties.** PS.9-12.5
6. **Develop a model to illustrate that the release or absorption of energy from chemical reactions is dependent upon changes in total bond energy.** PS.9-12.6
7. **Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.** PS.9-12.7
8. **Refine the design of a chemical system by specifying changes in conditions that would alter the amount of products at equilibrium.** PS.9-12.8
9. **Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** PS.9-12.9
10. **Analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.** PS.9-12.10
11. **Use mathematical representations to demonstrate how total momentum of a system is conserved when there is no net force on the system.** PS.9-12.11

12. **Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes forces on an object during collisions.** PS.9-12.12

13. **Use a mathematical representation of Newton's Law of Gravitation and Coulomb's Law to explain gravitational and electrostatic forces between objects.** PS.9-12.13

14. **Plan and conduct investigations to provide evidence that electric currents can produce magnetic fields and changing magnetic fields can produce electric currents.** PS.9-12.14

15. **Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component and energy flows in and out of the system are known.** PS.9-12.15

16. **Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles and energy associated with the relative position of particles.** PS.9-12.16

17. **Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.** PS.9-12.17

18. **Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system.** PS.9-12.18

19. **Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the change in energy of the objects due to the interaction.** PS.9-12.19

20. **Use mathematical representations to support a claim regarding relationships among the frequency, amplitude, wavelength, and speed of waves traveling in various media.** PS.9-12.20

21. **Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** PS.9-12.21

22. **Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** PS.9-12.22

23. **Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** PS.9-12.23

Life Science

1. **Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.** LS.9-12.1
2. **Develop and use a model to illustrate the organizational structure of interacting systems that provide specific functions within multicellular organisms.** LS.9-12.2
3. **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** LS.9-12.3
4. **Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** LS.9-12.4
5. **Construct an explanation based on evidence from multiple sources for how carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur may combine with other elements to form organic macromolecules with different structures and functions.** LS.9-12.5
6. **Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** LS.9-12.6
7. **Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** LS.9-12.7
8. **Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** LS.9-12.8
9. **Use mathematical or computational representations to support arguments about environmental factors that affect carrying capacity, biodiversity, and populations in ecosystems.** LS.9-12.9
10. **Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** LS.9-12.10
11. **Design, evaluate, and refine a solution for reducing the direct and indirect impacts of human activities on the environment and biodiversity and analyze scientific concepts used by American Indians to maintain healthy relationships with environmental resources.** LS.9-12.11
12. **Construct an explanation using evidence from multiple sources to describe the role of cellular division and differentiation in producing and maintaining complex organisms.** LS.9-12.12

13. **Make and defend a claim based on evidence from multiple sources that inheritable genetic variations may result from:
new genetic combinations through meiosis
viable errors occurring during replication
mutations caused by environmental factors
** LS.9-12.13

14. **Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** LS.9-12.14

15. **Evaluate and communicate scientific information about how common ancestry and biological evolution are supported by multiple lines of empirical evidence.** LS.9-12.15

16. **Construct an explanation based on evidence that the process of evolution by natural selection primarily results from four factors:
the potential for a species to increase in number
the heritable genetic variation of individuals in a species due to mutation and sexual reproduction competition for limited resources
the proliferation of those organisms that are better able to survive and reproduce in the environment ** LS.9-12.16

17. **Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** LS.9-12.17

18. **Construct an explanation based on evidence for how natural selection leads to adaptation of populations over time.** LS.9-12.18

19. **Evaluate the evidence supporting claims that changes in environmental conditions may result in:
changes in the number of individuals of some species
the emergence of new species over time
the extinction of other species
investigate and explain American Indian perspectives on changes in environmental conditions and their impacts
** LS.9-12.19

Earth and Space Science

1. **Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.** ESS.9-12.1

2. **Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.** ESS.9-12.2

3. **Communicate scientific ideas about the way stars, over their life cycle, produce elements.** ESS.9-12.3

4. **Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.** ESS.9-12.4

5. **Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** ESS.9-12.5

6. **Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.** ESS.9-12.6

7. **Develop a model to illustrate how earth's internal and surface processes operate at different spatial and time scales to form continental and ocean-floor features.** ESS.9-12.7

8. **Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other earth systems.** ESS.9-12.8

9. **Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.** ESS.9-12.9

10. **Plan and conduct an investigation of the properties of water and its effects on earth materials and surface processes.** ESS.9-12.10

11. **Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** ESS.9-12.11

12. **Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** ESS.9-12.12

13. **Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** ESS.9-12.13

14. **Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** ESS.9-12.14

15. **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** ESS.9-12.15

16. **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.** ESS.9-12.16

17. **Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, biodiversity, and investigate and explain how some American Indian tribes use scientific knowledge and practices in managing natural resources.** ESS.9-12.17

18. **Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** ESS.9-12.18