Fairfield Public Schools
Science Curriculum

Grade 8 Science

Grade 8 Science: Description

Students in middle school continue to develop understanding of four core ideas in the physical sciences. The middle school performance expectations in the Physical Sciences build on the ideas and capabilities that allow learners to explain phenomena. The performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain real world phenomena. Performance expectations at the middle school level focus on students developing understanding of several scientific practices that demonstrate the core ideas. Some of these practices include developing and using models, planning and conducting investigations, analyzing and interpreting data, and constructing explanations for scientific phenomenon. Students are also expected to demonstrate understanding of several of engineering practices including design and evaluation.

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:
Disciplinary Core Ideas (DCIs): Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.
Science and Engineering Practices (SEP): These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.
Crosscutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

Grade 8 Science

Enduring Understandings
Within a system of objects, there are a variety of forces acting on objects at all times affecting motion. Energy can be stored, transferred, or transformed, but it cannot be destroyed. Waves may be made of matter or energy and follow predictable patterns when they interact with matter. The properties of matter can be explained by atomic and molecular interactions.

Course Essential Questions
• How can one describe physical interactions between objects and within systems of objects? • How can energy be transferred from one object or system to another? • What are the characteristic properties of waves and how can they be used? • How do atomic and molecular interactions explain the properties of matter?

Course: Year-at-a Glance

Unit	Title	Unit Essential Questions
1	Motion and Stability: Forces and Interactions	• How do we know that forces exist if we cannot see them? • How can we predict the effect of forces on the motion of objects?
2	Energy	• How can technology be used to construct a device that minimizes or maximizes thermal energy transfer? • How do changes to the arrangement of objects affect the potential energy stored in the system? • How is temperature affected by thermal energy transfer, type of matter and mass of sample?
3	Waves and Electromagnetic Radiation	• How can a wave be qualitatively and quantitatively described? • How are waves reflected, absorbed or transmitted through various materials?

4	Matter and its Interactions	● How can models be used to describe the atomic composition of simple molecules and extended structures? ● How do we use natural resources to make synthetic materials, and how does doing so impact society? ● How can models be used to describe that the total number of atoms does not change in a chemical reaction and thus mass is conserved?

Unit 1: Motion and Stability: Forces and Interactions

Overview

Gravitational interactions are always attractive but electrical and magnetic forces can be both attractive and negative.
Objects can exert forces on each other through fields even though they are not in contact.

Performance Expectations

At the conclusion of this unit, students will be able to:
MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Unit Essential Question

- How do we know that forces exist if we cannot see them?
- How can we predict the effect of forces on the motion of objects?

Crosscutting Concepts

Cause and Effect
▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3),(MS-PS2-5)
Systems and System Models
▪ Models can be used to represent systems and their interactions - such as inputs, processes and outputs - and energy and matter flows within systems. (MS-PS2-1),(MS-PS2-4),
Stability and Change
▪ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different

scales. (MS-PS2-2)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

PS2.A: Forces and Motion

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)

- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions

- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
- Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Asking Questions and Defining Problems

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2)
- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

Engaging in Argument from Evidence

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

Corresponding CT Core Standards: **ELA/Literacy –** RST.6-8.1, RST 6.8.3, WHST 6-8.1, WHST 6-8.7 **Mathematics –** MP.2, 6.NS.C.5, 6.EE.A.2, 7.EE.B.3, 7.EE.B.4

Unit 2: Energy

Overview

The interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
Moving objects have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions.

Performance Expectations

At the conclusion of this unit, students will be able to:

MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Unit Essential Questions

- How can technology be used to construct a device that minimizes or maximizes thermal energy transfer?
- How do changes to the arrangement of objects affect the potential energy stored in a system?
- How is temperature affected by thermal energy transfer, the type of matter, and the mass of the sample?

Crosscutting Concepts

Scale, Proportion, and Quantity

- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1),(MS-PS3-4)

Systems and System Models

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2)

Energy and Matter

- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (MSPS3-3)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

PS3.A: Definitions of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

PS3.C: Relationship Between Energy and Forces

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

- Develop a model to describe unobservable mechanisms. (MS-PS3-2)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)

Analyzing and Interpreting Data

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

Engaging in Argument from Evidence

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Corresponding CT Core Standards:

ELA/Literacy – RST.6-8.1, RST 6-8.2, RST 6.8.7, WHST 6-8.1, WHST 6-8.7, SL 8.5

Mathematics – MP.2, 6.RP.A.1, 6.RP.A.2, 7.RP.A.2, 8.EE.A.1, 8.EE.A.2, 8.F.A.3, 6.SP B.5

Unit 3: Waves and Electromagnetic Radiation

Overview

Describe and predict characteristic properties and behaviors of waves when the waves interact with matter.
Apply an understanding of waves as a means to send digital information.

Performance Expectations

At the conclusion of this unit, students will be able to:
MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Unit Essential Questions

- How can a wave be qualitatively and quantitatively described?
- How are waves reflected, absorbed or transmitted through various materials?

Crosscutting Concepts

Patterns

- Graphs and charts can be used to identify patterns in data. (MS-PS4- 1)

Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials canbe shaped and used. (MS-PS4-2)
- Structures can be designed to serve particular functions. (MS-PS4-3)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

PS4.B: Electromagnetic Radiation

- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2)
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)

PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

1. Develop and use a model to describe phenomena. (MS-PS4-2)

Using Mathematics and Computational Thinking

2. Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)

Obtaining, Evaluating, and Communicating Information

3. Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)

Corresponding CT Core Standards:

ELA/Literacy – RST.6-8.1, RST 6.8.2, RST 6-8.9, WHST 6-8.9, SL 8.5

Mathematics – MP.2, MP.4, 6.RP.A.1, 6.RP.A.2, 6.RP.A.3, 8.F.A.3

Unit 4: Matter and its Interactions

Overview

Molecular level accounts explain states of matters and changes between states.
Chemical reactions involve regrouping of atoms to form new substances, and that atoms rearrange during chemical reactions.

Performance Expectations

At the conclusion of this unit, students will be able to:

MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Unit Essential Questions

- How can models be used to describe the atomic composition of simple molecules and extended structures?
- How do we use natural resources to make synthetic materials and how does doing so impact society?
- How can models be used to describe that the total number of atoms does not change in a chemical reaction and thus mass is conserved?

Crosscutting Concepts
Patterns ▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) **Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **Scale, Proportion, and Quantity** ▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Energy and Matter** ▪ Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6) **Structure and Function** ▪ Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)

NGSS Unit Standards

DICIPLINARY CORE IDEAS (DCI):

PS1.A: Structure and Properties of Matter

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
- (MS-PS1-4)

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)
- Some chemical reactions release energy, others store energy. (MS-PS1-6)

PS3.A: Definitions of Energy

- The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MSPS1-4)
- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

- Develop a model to predict and/or describe phenomena. (MS-PS1-1),(MS-PS1-4)
- Develop a model to describe unobservable mechanisms. (MS-PS1-5)

Analyzing and Interpreting Data

- Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)

Constructing Explanations and Designing Solutions

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MSPS1-6)

Obtaining, Evaluating, and Communicating Information

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each
- publication and methods used, and describe how they are supported or not supported by evidence.(MS-PS1-3)

Explain Natural Phenomena

- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

Corresponding CT Core Standards:

ELA/Literacy – RST.6-8.1, RST 6-8.7, WHST 6-8.8, **Mathematics –**6.EE.C.9

Mathematics – MP.2, MP.4, 6.RP.A.3, 6.NS.C.5, 8.EE.A.3